MASSACHUSETTS
AGRICULTURAL EXPERIMENT STATION

BULLETIN NO. 398 JANUARY, 1943

Annual Report

For the Fiscal Year Ending November 30, 1942

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

MASSACHUSETTS STATE COLLEGE
AMHERST, MASS.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

Trustee Committee on Experiment Station

	Term Expires
MALCOLM, DAVID J., Charlemont, *Chairman*	1946
WEBSTER, LOUIS, *Acting Commissioner of Agriculture*	
MCNAMARA, MRS. ELIZABETH L., Cambridge	1944
HUBBARD, CLIFFORD C., Norton	1946
WHITMORE, PHILIP F., Sunderland	1948
BRETT, ALDEN C., Watertown	1950

Experiment Station Staff, December 1942

HUGH P. BAKER, President of the College

SIEVERS, FRED J., Director
GASKILL, EDWIN F., Assistant to the Director
O'DONNELL, MARGARET H., Technical Assistant

HAWLEY, ROBERT D., Treasurer
FELTON, F. ETHEL, Editor
CHURCH, LUCIA G., Secretary

*ALEXANDER, CHARLES P., Entomology
ARCHIBALD, JOHN G., Animal Husbandry
§BERGMAN, HERBERT F., Cranberries
BOURNE, ARTHUR I., Entomology
*BRADLEY, LEON A., Bacteriology
COLBY, WILLIAM G., Agronomy
DORAN, WILLIAM L., Botany
*EISENMENGER, WALTER S., Agronomy
¶*FELLERS, CARL R., Horticultural Manufactures
*FRANDSEN, JULIUS H., Dairy Industry
†*FRANKLIN, HENRY J., Cranberries
°FREEMAN, MONROE E., Chemistry
FULLER, JAMES E., Bacteriology
*GAMBLE, PHILIP L., Economics
*GASKILL, EDWIN F., Station Service
*GRIFFITHS, FRANCIS P., Horticultural Manufactures
‡GUBA, EMIL F., Botany
*GUNNESS, CHRISTIAN I., Engineering
HASKINS, HENRI D., Agricultural Chemistry (Professor Emeritus)
HAYS, FRANK A., Poultry Husbandry
HOLLAND, EDWARD B., Chemistry (Professor Emeritus)
HOLMES, ARTHUR D., Chemistry
*HOLMES, JULIA O., Home Economics Nutrition
KIGHTLINGER, CLIFFORD V., Agronomy
‡*KOON, RAY M., Horticulture
KUZMESKI, JOHN W., Fertilizer Law
*LENTZ, JOHN B., Veterinary Science
*LINDSEY, ADRIAN H., Agricultural Economics and Farm Management
MCKENZIE, MALCOLM A., Botany
MORSE, FRED W., Chemistry (Professor Emeritus)
¶OLSON, CARL, JR., Veterinary Science
*OSMUN, A. VINCENT, Botany
*PARKHURST, RAYMOND T., Poultry Husbandry
*RICE, VICTOR A., Animal Husbandry
*RITCHIE, WALTER S., Chemistry
ROZMAN, DAVID, Economics
SHAW, JACOB K., Pomology
¶SIELING, DALE H., Chemistry
*SMITH, PHILIP H., Dairy, Feed, and Seed Laws
*SNYDER, GRANT B., Olericulture
*THAYER, CLARK L., Floriculture
*VAN METER, RALPH A., Pomology
VAN ROEKEL, HENRY, Veterinary Science
‡WHITCOMB, WARREN D., Entomology
WOOD, BASIL B., Library

BAILEY, JOHN S., Pomology
BENNETT, EMMETT, Chemistry
BROWN, ALFRED A., Agricultural Economics and Farm Management
BULLIS, KENNETH L., Veterinary Science
CREEK, CHARLES R., Agricultural Economics and Farm Management
†CROSS, CHESTER E., Cranberries
‡DEMPSEY, PAUL W., Horticulture
¶DEROSE, H. ROBERT, Feed and Fertilizer Laws
ESSELEN, WILLIAM B., JR., Horticultural Manufactures
FLINT, OLIVER S., Veterinary Science
¶FRANCE, RALPH L., Bacteriology
‡GILGUT, CONSTANTINE J., Nurseryculture
GUTOWSKA, MARIE S., Nutrition
JONES, CARLETON P., Chemistry
JONES, LINUS H., Botany
¶LEVINE, ARTHUR S., Horticultural Manufactures
MCLAUGHLIN, FREDERICK A., Seed Law
MUELLER, WILLIAM S., Dairy Industry
SMITH, C. TYSON, Feed and Fertilizer Laws
SPELMAN, ALBERT F., Feed and Fertilizer Laws
WERTZ, ANNE W., Home Economics Nutrition
‡WHITE, HAROLD E., Floriculture
‡YOUNG, ROBERT E., Olericulture

ANDERSON, JESSIE L., Seed Law
BECKER, WILLIAM B., Entomology
¶†BEMBEN, PETER, Olericulture
‡BOBULA, PAUL, Nurseryculture
BRINSON, JOSEPH E., Agronomy
BRUNELL, HARVEY J. Horticultural Manufactures
CLARKE, MIRIAM K., Veterinary Science
CROSBY, EARLE B., Veterinary Science
CROWLEY, LEO V., Feed and Fertilizer Laws
DAVIS, S. GILBERT, Horticultural Manufactures
¶‡DONNELLY, EDWARD B., Floriculture
‡GARLAND, WILLIAM, Entomology
HOWARD, JAMES T., Dairy, Feed, and Fertilizer Laws
JEWETT, FELICIA, Veterinary Science
KELLEY, JOSEPH L., Cranberries
KUCINSKI, KAROL J., Agronomy
MARTELL, JOSEPH A., Dairy, Feed, and Fertilizer Laws
MCCONNELL, JOHN E. W., Horticultural Manufactures
MINER, GLADYS L., Botany
‡MOODY, MARY, Olericulture
MORSE, ROY E., Horticultural Manufactures
PARKINSON, LEONARD R., Home Economics Nutrition
PERKINS, MARGARET K., Floriculture
SANBORN, RUBY, Poultry Husbandry
SHERBURNE, RUTH E., Economics
SOUTHWICK, LAWRENCE, Pomology
SPEAR, ARTHUR J., Home Economics Nutrition
STONE, ABIGAIL M., Agricultural Economics and Farm Management
TISCHER, ROBERT G., Horticultural Manufactures
‡TOMLINSON, WILLIAM E., JR., Entomology
WEIR, CLARA E., Home Economics Nutrition
WHITE, W. HENRY, Botany
‡WILSON, HAROLD A., Horticulture
YEGIAN, HRANT M., Agronomy
‡YOUNG, HELEN, Floriculture
YOURGA, FRANK, Horticultural Manufactures
ZATYRKA, IRENE E., Pomology

---

*In charge †At East Wareham ‡At Waltham §With U. S. D. A. ¶On Military Leave.

CONTENTS

ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION—1942

DEPARTMENT OF AGRICULTURAL ECONOMICS AND FARM MANAGEMENT

A. H. Lindsey in Charge

Competitive Factors Influencing the Supply of Market Milk and Cream in Massachusetts. (A. A. Brown and Abigail Stone.) Bulletin 389, the last of three bulletins based on the Springfield–Holyoke–Chicopee Milkshed, was published in 1942.

The organization of production and distribution of sales throughout the State are now being studied in relation to the program of the Massachusetts Division of Milk Control.

Transportation Requirements of Rural Communities in Massachusetts. (A. A. Brown and Abigail Stone.) A study of the amount of trucking necessary for the movement of grain to farmers in the Amherst–Pelham area is near completion. One cause for excessive mileage is the frequent buying in small amounts by many farmers. Much time and probably much mileage could be saved if farmers would place their grain orders monthly and take at one delivery quantities up to the permissible mileage of the handler's truck. This sort of arrangement would reduce stops by 50 percent and result in an average delivery of .48 tons per mile. Comparison with mileage under actual conditions was not possible because some operators kept neither trip nor mileage records. Study of farmers' buying practices indicates that worthwhile reduction in mileage could be accomplished by fully utilizing handler's equipment.

Crop and Livestock Enterprise Relationships. (C. R. Creek.)

Results of Pasture Improvement Practices. Detailed grazing records were kept for the 1941 season, in connection with a record of milk production, barn feeding, and pasture treatment. Acreage of pasture ranged from 10 to 113 acres per farm with an average of 34 acres. More intensive improvement practices were applied to the small areas. Size of dairy herds ranged from 8 to 45 cows per farm with an average of 24 head. The length of pasture season was variable, chiefly because of drought in late summer, and ranged from 65 to 164 days with an average of 121.

Results from the grazing of these pastures were calculated in pounds of 4 percent milk, number of cow-days, and tons of green forage. For the relatively short season of 1941 an average of 2017 pounds of 4 percent milk was produced from each acre of improved pasture. The range per farm was from 313 to 6648 pounds per acre. Cow-days of grazing ranged from 22 to 152 on these farms with an average of 74 per acre. Production of green forage was calculated as an average of 2 tons per acre with a range from 0.5 to 3.0 tons per acre per farm. Returns for individual fields on these farms varied more widely than the range given for averages by farms.

Improved pastures consisted of annual crops, Ladino Clover, mixed clover and grass, and permanent grassland. Returns were highest for Ladino Clover pastures with 3,044 pounds of milk, 84 cow-days, and 2.7 tons of forage per acre. Clover and grass pastures ranked second, followed by annual pasture crops and permanent pastures. Returns were also calculated by types of treatment, but the variation was slight.

Labor-Saving Methods and Practices on Massachusetts Farms. (C. R. Creek.) An outline has been prepared to apply the results of previous research on labor-saving practices to the production and harvesting of vegetable crops on small farms. Inexpensive and homemade adaptations of labor-saving equipment are recommended for these farms.

Comparative Costs of Producing Corn and Grass Silage. (C. R. Creek.) Preliminary tabulations and calculations have been made of various items in the cost of producing corn and legume–grass silage on dairy farms in the Connecticut Valley counties. Cash costs of growing and harvesting corn for silage ranged from less than $1 per ton on a farm with no hired labor and no fertilizer expense to $5.06 per ton on a farm where machinery was hired for all growing and harvesting work and all labor was hired. Total costs were much higher and ranged from $4.93 to $9.13 per ton. Total costs included such non-cash items as family labor, depreciation, interest, and the value of manure. The acreage of corn for silage ranged from 3 to 21 acres per farm with a total production of 20 to 200 tons. Yields ranged from 5 to 16.5 tons per acre.

Cash cost of legume–grass silage ranged from $2.37 to $3.60 per ton and total costs from $5.30 to $9.45 per ton. Acreage of the various crops ranged from 2.5 to 40 acres per farm and yields of grass silage were from 3.8 to 8 tons per acre. Small acreages of oats used as a nurse crop for clover seedings were ensiled on a few farms. Cash costs ranged from $2.55 to $4.53 per ton and total costs from $5.90 to $10.69. Yields varied between 6 and 10.5 tons per acre of oats for silage.

Loan Performance on Low-Income Farms in Massachusetts. (C. R. Creek.) Data and information have been obtained from the farm plans for Farm Security Administration borrowers in Franklin, Hampden, and Hampshire counties. Tabulations have been made by counties for cash-crop and for livestock farms. Preliminary observations indicate that the rate of repayment of loans has been much higher on the cash-crop (onions, tobacco, and potatoes) farms than on the dairy and poultry farms. A small number of the latter have been liquidated at public auction to repay the Farm Security Administration loans.

The chief reason for loans to cash-crop farmers in the Connecticut River Valley was the loss of crops in the flood and hurricane of 1938. Low prices for crops and low yields in earlier years were responsible for the deplorable credit situation of many small operators. Increasing the size of business from a part-time or subsistence level was the reason for many livestock loans, particularly on poultry farms. Some of these operators have now returned to a part-time farm business and are working in industrial plants in nearby cities.

DEPARTMENT OF AGRONOMY

Walter S. Eisenmenger in Charge

Tobacco Projects. (Walter S. Eisenmenger and Karol J. Kucinski.)

Brown Root-Rot of Tobacco. In the experiment to determine the effect of preceding crops on tobacco it was found that tobacco, artichoke, and sunflower, as well as fallow, were beneficial as contrasted with such crops as corn, sudan grass, and sorghum, which in all cases seemed to have a deleterious effect on yield.

The crops preceding tobacco were planted at three different times: the first, early; the second, thirty days later; and the third, thirty days later than the second. The earliest planting was completely mature; the others matured to a lesser degree. The earliest planting developed more lignin than the others. These plants were permitted to stand and become thoroughly dehydrated by subsequent freezing and thawing.

Where the individual plants were of the type that prevents the growth of weeds —shade producing plants—the yield of tobacco increased after the late plantings. In plots of small plants, such as barley, rape, and rye, the weeds in late summer intrude and to a degree vitiate the results.

There is no evidence, however, of a better quality of tobacco grown after immature plants. This is not entirely new, for it is often the case that larger tobacco plants do not cure as well as smaller tobacco plants.

Tobacco Experiments with Application to Soil of Commercial Organic Materials. Different types of carbon compounds were applied to the soil to study their effect on the yield of tobacco. Because of prohibitive cost, there are not many such compounds that can be used; but cane sugar, starch, dried skim milk, and charcoal were each applied to duplicate plots at the rate of 100 pounds per acre. No decided differences were noted in the tobacco although the check plots receiving no additions of carbon were low in yield and crop index. The charcoal caused more rapid growth in the early season, probably because of the more abundant absorption of heat by the darker color induced, and also gave the highest yield, suggesting the possibility of its use in early spring for frames where seedlings are grown. The dried milk left a residual effect the following year for the cover crop of rye. Increased growth on these two plots was pronounced, suggesting two possible factors—the nitrogen in the milk, or the subsequent action of lactic acid which may have influenced the soil flora.

The Absorption by Food Plants of Chemical Elements Important in Human Nutrition. (Walter S. Eisenmenger and Karol J. Kucinski.) Calcium, magnesium, sodium, and potassium salts, at the rate of 200 parts per million of each cation, were added singly to soil growing vegetables. The increase of these cations in plant tissue, when cations were added singly to the soil was as follows: for cabbage—calcium 30 percent, potassium 127 percent, magnesium 543 percent, and sodium, none; for celery—calcium 44 percent, potassium 256 percent, magnesium 390 percent, and sodium 52 percent; for lettuce—calcium 12 percent, potassium 132 percent, magnesium 346 percent, and sodium 72 percent; for carrots —calcium 18 percent, potassium 24 percent, magnesium 42 percent, and sodium 106 percent; and for beet roots—calcium 22 percent, potassium 12 percent, magnesium 85 percent, and sodium 356 percent.

Larger amounts of magnesium, potassium, and sodium can be introduced into plants than of calcium. Also, more of the halides can be introduced into plants than of phosphorus or sulfur.

It may be said that those elements which are abundant in sea water may be introduced into plants more readily than the elements which are abundant in land waters.

The Intake by Plants of Elements Applied to the Soil in Pairs Compared to the Intake of the Same Elements Applied Singly. (Walter S. Eisenmenger and Karol J. Kucinski.) Cabbage, celery, lettuce, and string beans were grown after application to the soil of 250 parts per million each of calcium, sodium, and potassium, singly and also in all possible combinations. Results show that when these ions were applied in pairs, the amounts taken in by the plant were lower than when they were applied singly. This behavior is suggestive of the well-known premise that up to a certain point one of these elements can serve the function or purpose of the other.

Magnesium Requirements of Plants. (Walter S. Eisenmenger and Karol J. Kucinski.) Nearly one hundred species of plants have been grown on a magnesium deficient plot, one-fourth of which receives magnesium sulfate; one fourth

magnesium sulfate and lime; one-fourth, lime alone; and the other fourth, neither lime nor magnesium.

The demonstrations have developed to a significant degree—to show what plants need this element. However, the obvious chlorosis seems not to be the whole story; for we have found plants regarded as weeds which do not grow at all where no magnesium is added, and one cultivated plant which does not chlorose but does much better if magnesium is added, and there are plants which have symptoms of potassium deficiency where no magnesium is added, as in the case of the apple tree.

Soil Conservation Research Projects. (Karol J. Kucinski and Walter S. Eisenmenger.)

A Study of the Physical and Chemical Properties of Wind-Blown Soils. Wind erosion in the Connecticut Valley occurs mostly on onion and vegetable fields when previously frozen soils thaw, then dry, and are swept off by drying, northwesterly winds. In general, these wind-blown soils are coarser than the soils least affected. It is important from both the practical and academic viewpoints to find out just what physical-chemical properties determine the degree of erodibility of a soil, which of these properties are controllable, and what takes place in the soil complex when one or more of these properties are changed.

During the past year, in cooperation with the Soil Conservation Service, the problem of wind erosion has been studied. Soils from wind-eroded and uneroded areas are being examined by the use of a wind tunnel 32 feet long by 3 feet by 3 feet, especially designed for local conditions. Wind velocities as high as 50 miles an hour can be generated and instruments are used to record the wind velocities and amounts of erosion. Preliminary trials with the tunnel have given interesting results, and it is expected that the information finally obtained will help greatly in understanding why certain soils erode more than others and possibly in establishing means for their stabilization.

A Survey of Erosion Problems Arising from Changes in Land Use. The growing of potatoes on a large scale is a relatively new venture on some of the farms in Massachusetts, especially in the western foothills and plateau. Many acres of old sod have been plowed under on the sloping hillsides—in some cases, fields which have not been in open cultivation for the past thirty years. The potato yields from such fields have been very encouraging and in most cases, therefore, the operators have not been interested in soil conservation practices. As yet, only slight sheet erosion is noticed, probably because of the presence of large amounts of organic matter. Great concern has been felt by some who think that after a few years of open cultivation, the organic matter originally present in these new potato fields will decompose and the soil will readily erode, since cover cropping has not been practiced.

Determinations of carbon and loss on ignition indicate that a large decrease in the organic matter content of some of these soils has already taken place. There was an average decrease of 9.5 percent of soil carbon in 1940 compared with 1939 and a 21 percent decrease in 1942 compared with 1939. The "loss on ignition" of this same soil, which is a measure of organic matter, showed an average decrease of over 10 percent. It is deemed advisable, therefore, to encourage potato growers to practice soil conservation methods such as winter cover cropping and terrace and contour farming of their hillsides.

Sunflowers and their Possibilities. (Karol J. Kucinski and Walter S. Eisenmenger.) For the past four or five years, sunflowers have been grown in the hope of finding out whether the crop is adapted to our soil and climate. Results show that sunflowers can be grown here and produce seed abundantly. However, to

the best of our knowledge, no one in Massachusetts is growing sunflowers in commercial lots, probably because of the lack of proper mills for processing the oil. The cost of transportation to mills in the Midwest would not justify shipment even in normal times. Some seed is grown locally and used as a conditioner of poultry.

Sunflowers will grow in Massachusetts on any land which will produce field corn and a corn fertilizer seems to do very well. There is an element of risk involved in the growing of the crop which should not be overlooked. The plant is very susceptible to damage from windstorms and there was complete crop failure after the 1938 hurricane. The "wind-fall" of the sunflower plant is due to a large extent to infestation with the corn borer. Planting the seed too close will produce small and thin sunflower plants, too weak to withstand strong windstorms. One seed per hill every 18 inches in 36-inch rows gave an average crop of over 2 tons of clean seed per acre. The wholesale price of sunflower seed quoted on the western coast ranges from seven to eight cents a pound.

Sunflowers are hardy to light frost, and can be planted at the time it is safe to plant field corn. Harvesting is usually done during the latter part of September. A growing period of 120 to 140 days, depending on the season, is sufficient for maturing the seed in Massachusetts. It has been found best to cut the sunflower heads off the stalk and place them singly on boards to dry for two or three weeks. This drying facilitates the removal of the seed from the head by striking the head against some object or rubbing it on a very coarse wire screen.

Black Root-Rot of Tobacco. (C. V. Kightlinger.) The project to improve tobacco production in Massachusetts by producing strains of Havana Seed which are satisfactorily resistant to black root-rot and also acceptable in type, quality, yielding capacity, and habits of growth in general, is being continued. Strains of tobacco which possess most of these properties have been produced, but they have not been entirely acceptable to some leaders of the tobacco trade. Attempts to improve the strains by selection have succeeded in making changes but only in minor properties. New strains produced by breeding show promise of producing the desired results.

Results obtained from small plot tests show two of the new strains to yield well not only in soil free from black root-rot, but under bad black root-rot promoting conditions, as well. They have good general type and produce leaves which have good shape, smaller veins than many strains, and good body and quality. These strains mature as early as the common Havana Seed which was used as one of the parents and bear a close resemblance to that parent in most respects. They have not yet been tested in commercial production.

Brown Root-Rot of Tobacco (C. V. Kightlinger.) The project to determine the effects that high and low fertility of the soil may have on the occurrence of brown root-rot of tobacco is in progress, but work has not yet gone beyond the treatment of soil necessary to produce those differences in fertility.

Soil Treatments for Tobacco Seedbeds. (C. V. Kightlinger.) Experiments were made again during the fall of 1941 and the spring of 1942, to test the effectiveness of several different soil treatments in controlling damping-off diseases, but results were disappointing because even the control plots showed no evidence of the disease.

In the control of weeds, there were wide differences between the different treatments; also, between replications of the same treatment, except in the case of steaming and the combination treatments with chloro-picrin and calcium cyanamid. Steaming was done by the pan method at a steam pressure of about 100 pounds applied for 20 minutes, with the pan kept in place for another 20 minutes.

This gave good control of weeds in all replications, whether done in the fall or in the spring. The combination treatment of chloro-picrin and calcium cyanamid consisted of 2 cc. of chloro-picrin per square foot and one-half pound of calcium cyanamid per square yard of soil surface, applied only in the fall. This treatment was not so effective as steaming, but it gave fair control of weeds in most of the replications.

Onion Breeding. (Hrant M. Yegian.) Tests were made during the season of 1942 on the Hubbard farm in Sunderland, Massachusetts, to compare the yields of onions obtained from sets planted by machine with yields of onions obtained from sets planted by hand, and to determine the effect that spacing of sets within the row might have on both the yield and size of bulbs produced.

The sets planted by hand yielded an average of 51 pounds of Number 1 onions per 50-foot row, compared with 33.5 pounds for machine-planted sets with supplementary hand work for checking and respacing. With the machine, the spacing and the yield are not uniform. The number of plants in a 50-foot row varied from 153 to 218, compared with 238 to 264 plants per row in the hand-planted sets. The yield obtained from machine-planted sets varied from 29 to 44 pounds compared with 49 to 54.5 pounds from hand-planted sets. Another important factor affecting the yield and the stand of machine-planted sets is the fact that sets are not always placed in an upright position. There was a loss of 25 percent in yield when sets were placed horizontally in the row by hand, and 80 percent when planted bottoms up in the experimental plot at the College. These figures will, of course, vary from year to year depending on weather conditions prevailing soon after the sets are planted. The weather during April and the early part of May this season was very dry and warm, which may account for the poor start made by sets planted horizontally or bottoms up. Although the machine-planted sets did not yield as well as the hand-planted sets, it would seem that the use of this machine should be encouraged in the Valley because of the saving in labor. Even spacing could be secured by carefully sizing the sets into several grades.

Spacing of sets in the row had a marked influence on the yield and to some extent on the size of the bulbs. When sets were spaced 2.1 inches, 3.2 inches and 4.2 inches apart in the rows, the average yields of Number 1 onions were 51 pounds, 40.5 pounds, and 32.5 pounds per 50-foot row, respectively; and the average weight of bulbs was 0.2 pounds, 0.22 pounds, and 0.23 pounds, respectively.

The data covering one year of field experiments on the effect of storage temperatures on the keeping quality of bulbs and on the subsequent seed-stalk development of mother bulbs at uniform weight (40–45 grams) warrant the following general statement:

1. Bulbs stored at 32°F. kept best. Bulbs stored at 45° had 15 percent of sprouting, while those stored at 60° – 70° had 18 percent of sprouting and 5 percent of soft rot.

2. Bulbs stored at 45°F. were the first to send out seed stalks, followed by those stored at 60° – 70°. The bulbs stored at 32° were 7 – 10 days later than those stored at 45°.

3. The storage temperature had a marked effect on the number of seed stalks produced. When bulbs were stored at 60° – 70°F., 33 percent of the bulbs had 2 seed stalks per bulb; 30 percent, 3 seed stalks; and 25 percent, 4 seed stalks; when stored at 45°, 53 percent of bulbs had 2 seed stalks per bulb; 32 percent, 3 seed stalks; and 8 percent, 4 seed stalks; and when stored at 32°, 76 percent of the bulbs had 2 seed stalks per bulb; 17 percent, 3 seed stalks; and 4 percent, 4 seed stalks.

Although the amount of seed produced by the several lots of bulbs differed, it is not certain that the storage temperatures were entirely responsible for these differences. Further investigation of this phase of the problem is needed.

There was no significant difference in time of maturity between commercially grown onions in the Valley and onions grown from sets selected for early and late maturity. On account of weather conditions this year, commercially grown onions matured from 2 to 3 weeks earlier than usual, which may explain the failure to obtain any advantage from using specially selected sets.

Sets were produced this year from second generation selfed lines for the study of inheritance of number of seed stalks per plant; from crosses for double and single bulb characters; and from crosses between white Persian and Ebenezer variety. F_2 seed was secured from the white Persian × Ebenezer cross.

Sterile-species crosses between *Allium fistulosum* and *A. cepa* L. were treated with calchicine to induce polyploidy. Calchicine in a 2 percent aqueous solution was lethal to all the early stages of inflorescence when immersed for one hour, and few of the flowers that were about ready to open on well-developed inflorescence survived the treatment. Their stigmas were stunted and swollen and no pollen ripened. One of the hybrids which was not treated with calchicine matured 5 seeds. These seeds were planted as soon as mature, in the greenhouse. Although all of the seeds germinated, only two seedlings survived. Cytological examination of the meristematic tissues will be made to determine the chromosome number of these plants.

The hybrids of the *A. fistulosum* × *A. cepa* cross show the characteristics of multiplier onion. One of the year-old bulbs separated into 16 parts, each bulblet having a flower-stalk.

Hybrid Field Corn. (Hrant M. Yegian.) Further trials with early-maturing hybrid field corn for the higher plateau regions of Worcester County and the western counties of Massachusetts were conducted at the College Farm. A few of the promising hybrids will be tested next season in the northern part of the State.

Nine early-maturing hybrids—Maine A, Wis. 240, Wis. 255, Minn. 402, Minn. 700, Minn. 800, Cornell 34-53, Ohio M15, and Quebec flint—from last year's trial plots at the College were tested this year for maturity and yield in the northern part of the State where the growing season is shorter and cooler than it is here. Maine A was the only one that matured under those conditions.

In order to become familiar with the performance of recently developed out-of-state hybrids offered for sale in Massachusetts for late grain and silage purposes, yield tests with 27 hybrids were conducted at the College Farm. The year 1942 was very favorable for corn production. The long ripening season permitted relatively large, late-maturing hybrids to ripen satisfactorily; but in a year with a shorter ripening season, the results may be very disappointing.

Available Phosphorus. (A. B. Beaumont.) The distribution of "available" phosphorus in the soil profile as affected by soil type and management is being studied. Determinations of soluble phosphorus made to date indicate that past treatment is a more important factor in determining the amount of phosphorus extracted by this method than is soil type. Long use of phosphatic fertilizers has caused an accumulation of acid-soluble phosphorus in the topsoil, the amount varying with the degree of fertilization. Topsoils which have been heavily fertilized for years, as in truck growing and tobacco culture, have been found to be relatively heavily charged with phosphorus considered available by the method of extraction used. Corresponding subsoils have been found to contain little available phosphorus.

Potato Variety Trials. (Ralph Donaldson, Walter S. Eisenmenger, and Karol J. Kucinski.) Based on yields of marketable size, the ranking of potato varieties grown in plots at the college during the season of 1942 were Sequoia, Pontiac, Green Mountain, Houma, Red Warba, Russet Rural, Chippewa, Earlaine, S-46592, Katahdin, Sebago, S-46000, and Irish Cobbler.

Ryegrass as a Green Manure Crop. (Hrant M. Yegian.) The use of domestic ryegrass (*Lolium* sp.) as a winter cover crop and green manure is becoming more or less a general practice on the better-managed vegetable farms. It is one of the best all-round winter cover crops in this region, where the temperature during the growing season in the fall is moderately cool. Ryegrass is easily grown, and on fertile soil makes a complete cover quickly. Its heavy mat of roots retards severe soil erosion from wind or rapid run-off of rain. It may be seeded, in most cases, as soon as the previous crop is removed. With set onions, ryegrass may be seeded at the rate of 20–25 pounds per acre, in the early part of August, after the onions have been harvested and moved out of the field, although seeding even as late as the early part of September has given a satisfactory cover crop at this station. The yield (0.5–1.5 tons of dry tops) will vary, depending upon the time of seeding and the amount of available moisture and plant nutrients during the growing period. It is moderately winter-hardy. From 50 to 60 percent of the plants will survive the average winter; so unless the ryegrass is completely turned under in the spring during the plowing operation, volunteer plants may interfere with the cultivation of the subsequent crop. Experience here has shown that a very satisfactory seedbed for the set onion crop can be prepared by plowing under the cover crop in early spring.

Influence of Soil Fertility on Productiveness of Pasture Species. (Hrant M. Yegian.) In 1941 a field plot experiment was started with thirteen species of grass to determine their relative productivity and ability to winter over and to recover from cutting. These grass plots were maintained in pure stand at different levels of soil fertility which were secured by the addition of lime (1000 pounds per acre) and 5-8-7 fertilizer in increments of 400 pounds per acre. Data covering the second year of the experiment warrant the following statement:

All the species continued to respond as well in their second year as in their first, to increases in soil fertility levels.

The soil fertility requirements of different species vary. There was a pronounced or consistent increase in yield with additional applications of commercial fertilizer, but the percentage increase in yield was not the same for all the species at each level of soil fertility. Reed canary grass, colonial bent, orchard grass, and Kentucky bluegrass produced proportionally more dry tops at the higher soil fertility levels (800 to 1600 pounds of 5-8-7 fertilizer per acre); while timothy, fowl bluegrass, red top, and meadow fescue produced proportionally more dry tops at the lower levels (400 to 800 pounds of 5-8-7 fertilizer per acre); and there were a few species, including meadow foxtail and smooth brome grass, that produced in direct proportion to the amount of fertilizer added.

The perennial ryegrass was completely winterkilled in its second year. Kentucky bluegrass, reed canary grass, timothy, and smooth brome grass gave a greater yield in their second year than in the first in the fertilizer plots; meadow fescue, colonial bent, orchard grass, rough-stalked meadow grass, and meadow foxtail produced less in their second year; while red top and fowl bluegrass maintained their yield at the same level both years.

Experiments at Amherst with Hay and Pasture Seeding Mixtures. (W. G. Colby.) Additional data were obtained from three series of plots planted with different hay and pasture seeding mixtures in 1940 and 1941. Details of the

plan of the experiment were given in last year's report (Mass. Agr. Expt. Sta. Bul. 388:14-15, 1942).

Yields of both hay and pasture herbage on plots seeded in 1940 were lower this year than last year. Plots which produced at the rate of 3½ to 4 tons of dry matter per acre last year produced 3 to 3½ tons this year. Reduced yields resulted, notwithstanding the fact that growing conditions so far as the weather was concerned were much more favorable this past season than they were a year ago. Total rainfall for the period from March 1 to November 1, 1942, amounted to 30.55 inches, slightly above normal for this period, whereas the total rainfall for the same period in 1941 was only 22.02 inches.

These experimental results are consistent with what has been observed in newly seeded hay and pasture lands in Massachusetts for many years. Unless weather conditions or other circumstances are extremely unfavorable, yields will be highest the year following seeding. This is true for both spring and summer seedings. Yields can be expected to fall for two to three years following the second year of maximum production until a fairly constant production level is reached, which will approximate one half to two thirds of the maximum figure. Careful grazing management in pastures and regular topdressing applications of suitable fertilizers will slow up the rate of decrease, but they will not prevent it. Managed grazing of the plots in this experiment, together with a topdressing application of 200 pounds of 40 percent superphosphate and 325 pounds of muriate of potash per acre in the fall of 1941, did not prevent yield levels from falling in 1942.

Of the three grasses—smooth brome grass, late-maturing types of orchard grass, and meadow fescue—which produced well in association with Ladino clover in 1941, only meadow fescue failed to compete satisfactorily in 1942. The total production of these grasses in association with Ladino clover was not only high but was fairly uniformly spread over the season. Smooth brome grass and Ladino clover for example, yielded 1015 pounds of dry herbage in May, 1600 pounds in June, 1065 pounds in July, 920 pounds in August, and 770 pounds in October. These yields may be compared with those from the timothy, alsike, red clover plots which were 1210, 1160, 770, 770, and 340 pounds for the same harvesting dates.

Promising results were again obtained from the series in which a crop of hay was cut followed by grazing. A mixture of smooth brome grass, Ladino clover, and alfalfa produced 4040 pounds of hay in mid-June, 1065 pounds of grazing in July, 1015 pounds in August, and 870 pounds in October. The timothy, alsike, red clover mixture yielded 5180 pounds of hay in late June, no grazing in July, 970 pounds in August, and 680 pounds in October.

Some of the leafy, late-maturing strains of orchard grass performed moderately well with Ladino clover and also when alfalfa was added, but the commercial strains of orchard grass were not satisfactory. In the pasture plots they were all too vigorous in their growth habits and tended to crowd out the legumes even though grazing was carefully controlled and the plots were clipped after each grazing period. In the hay plots these strains matured too early for the alfalfa.

Although the common variety of orchard grass has been frequently recommended to farmers, this grass has never found widespread favor. It has recently been recommended as a companion grass for Ladino clover. The past two years' results indicate that the reluctance on the part of farmers to grow it extensively is well founded. Except where soils are fertile and well supplied with moisture and also where grazing is carefully controlled and the means are available for clipping following grazing, disappointing results with Ladino clover and orchard grass are likely. Even under such circumstances no more than three to five pounds of the grass seed should be sown to the acre.

In an effort to eliminate some of the bad features of orchard grass, breeders have developed a number of new and improved strains. Several of these were included in the test and it is from some of these strains that promising results have been obtained. The outstanding one thus far is S37, a strain developed by the Welsh Plant Breeding Station in Aberystwyth, Wales. Three strains from this source were tested — S26, S37, and S143 — but S37 gave the best all-round performance. It is leafy, late-maturing, moderately vigorous and upright in its growth habit, and a reasonably good seed producer. It looked well in combination with both Ladino clover and alfalfa and appeared to be adapted for use as pasture or hay and pasture combined. A satisfactory proportion of legumes to grasses has been maintained for two years in plots seeded with five pounds of S37 orchard grass, two pounds of Ladino clover, and ten pounds of alfalfa.

Svalof's early meadow fescue, a short, narrow-leafed type, grew well the first season with Ladino clover, but was unable to maintain a stand throughout the second season. Commercial strains were eliminated the first season. The Svalof strain has been of interest, because it is apparently immune to leaf rust, a factor which may explain why it is more persistent than commercial strains. Although meadow fescue is apparently unsatisfactory when grown alone with Ladino clover, there are indications that five to eight pounds might be seeded along with four to five pounds of a leafy strain of orchard grass or eight to ten pounds of smooth brome grass, with excellent results. Meadow fescue is a fast-growing grass which establishes itself quickly and would retard weed growth and yield considerable feed while the slow-growing brome grass or orchard grass was becoming established.

Strains of the so-called tall meadow fescue, such as Alta tall fescue, have not performed satisfactorily. They are coarse and unpalatable in comparison with several of the other grasses and offer too much competition for Ladino clover.

DEPARTMENT OF ANIMAL HUSBANDRY

Victor A. Rice in Charge

A Study of the Mineral Elements of Cow's Milk. (J. G. Archibald, C. H. Parsons, and H. G. Lindquist.) For two reasons the work with manganese reported last year was repeated during the winter of 1941-42: (1) the findings were at variance with some earlier work at another station, so it was thought advisable to confirm them; (2) it was desired to investigate the possible effect of metabolized manganese on the development of oxidized flavor in milk.

The results of this second season's work confirmed the finding reported last year that the amount of manganese in milk can be doubled by adding manganese to the ration fed. This additional metabolized manganese did not retard or inhibit the development of oxidized flavor either in ordinary milk or in milk to which copper had been purposely added to accentuate the effect.

The element zinc is being studied this year.

Investigation of the Merits of Legume and Grass Silage for Massachusetts Agriculture. (J. G. Archibald and C. H. Parsons.) War economy has resulted in a definite shortage and a corresponding increase in price of the two most common preservatives for grass silage, molasses and phosphoric acid. Our efforts this year have, therefore, been devoted to a study of other materials which might possibly be used as preservatives, and to an improvement of methods in general so that smaller amounts of preservative or none at all, may suffice.

It was not possible to conduct any feeding trials with the molasses silage stored in the large experimental silo in June 1941. The excellent quality of this silage

was, however, very evident; the odor was mild and sweet, and the cows ate it much more readily than they did a similar lot preserved with phosphoric acid in the same silo the previous year.

A second silo containing 75 tons of mixed grass was inoculated at five different levels at filling time in June 1941, with a pure culture of *Bacillus bulgaricus*. No other preservative was used. This silo was opened in January 1942; there was considerable spoilage at the top and sides and the odor at first was very objectionable, indicating formation of excessive amounts of butyric acid. The odor improved after the top layers were fed off, but continued more sharply acid than the odor of the molasses silage referred to above, although the pH was 4.4 in contrast to 3.9 for the molasses silage. The station bacteriologist was unable to recover *B. bulgaricus* from the silage, which suggests that the inoculation may have played little if any part in the fermentation.

The silage was fed to young cattle; they ate it readily but made somewhat smaller gains than when fed corn silage. This may have been due, however, to inherent feeding value of the original material rather than to method of preservation. It would have been desirable to include another siloful of similar material not inoculated, as a control. This has been done this year, but at this date (Nov. 30) the silos have not been opened.

In addition to the three large silos filled this year, using respectively molasses, bacterial inoculation, and no preservative (control), sixteen miniature silos have been filled, each containing approximately one and a half bushels of chopped grass or alfalfa, and weighted with concrete blocks to produce a pressure of about 120 pounds to the square foot. Two crops, mixed grass and alfalfa, at two different moisture levels, have been ensiled in these miniature silos with the following treatments: (1) no preservative, (2) inoculation with *B. bulgaricus*, (3) salt, (4) *B. bulgaricus* plus salt. At date of writing (Nov. 30) six of these small silos have been opened and their contents studied from a biochemical, and to a lesser extent from a bacteriological standpoint. The outstanding facts thus far are: (1) the excessive amount of butyric acid which has developed regardless of the preservative used, and (2) the complete absence of lactic acid from these silages.

A Study of Urea as a Partial Substitute for Protein in the Rations of Dairy Cows. (J. G. Archibald.) This project has recently been discontinued for the duration of the war. Final conclusions are not being drawn at this time, but results of feeding trials extending over three years indicate that while the urea has been utilized by the cows to some extent it has not proved equal to the standard protein concentrates as a source of nitrogen for milking cows.

The Effect of Feeding Irradiated Dry Yeast on Reproduction and General Health in Dairy Cows. (J. G. Archibald and J. D. Neville.) Two years' results with sixty cows in the Gardner State Hospital herd show no differences of any significance between the cows getting irradiated yeast and those on the control ration. This lack of response may be due to the fact that this herd has always been maintained at a rather high nutritional level. The level of vitamin D fed was approximately 10,000 international units daily per cow.

Determination of the phosphatase level in the blood of twenty of these cows (ten in each group) at regular intervals during January, February, and March of this year showed no significant differences between the groups in this constituent. Since a rise in blood phosphatase is considered to be a sensitive indicator of vitamin D deficiency, it seems evident from these results that the cows in this herd were not suffering from even a slight deficiency of this vitamin; therefore, the lack of response to the feeding of irradiated yeast is quite understandable. The project in its present form and as involving the use of the Gardner herd has been terminated.

DEPARTMENT OF BACTERIOLOGY

Leon A. Bradley in Charge

Nitrification in Soils Containing Plant Residues of Varying Lignin Content. (James E. Fuller, cooperating with the Agronomy Department.) This investigation, so far as the field work is concerned, is obviously seasonal and consequently proceeds slowly. A preliminary statement was made in the 1941 report from this Department (Mass. Agr. Expt. Sta. Bul. 388: 19, 1942). The crops employed were millet, rye, wheat, sudan grass, sorghum, corn, oats, buckwheat, barley, rape, artichoke, tobacco, and sunflower. There were six plots with all of the crops in each, except the sunflower, which was alternated with fallow strips. The crops were grown and then plowed under. The following season tobacco was grown on the plots, and during that season three series of soil samples were collected — one early in the season before the tobacco was planted, another in mid-summer, and the third in the early autumn after the tobacco had been harvested. These samples were tested for their ability to nitrify dried blood and ammonium sulfate.

The general tendency seemed to be that the capacity of the soil to nitrify dried blood declined in mid-summer as compared to the spring, and then recovered to some extent later in the season. There was considerable variation among the different plots, and no definite relationship could be noted between the variety of crop and the nitrifying capacity of the soil of the plot. The ability of the soils to nitrify ammonium sulfate declined markedly, in general, when the early and mid-season samples were compared, and there was little recovery of activity when the late-season samples were analyzed.

The nitrification results are being compared with the production and the grade and crop indices of tobacco grown on the plots. No relationship has been noted, but further study of the data is being made.

The Determination of the Sanitary Quality of Drinking Utensils. (Ralph L. France and James E. Fuller.) This project had been carried on by France, and after he entered the armed service of the country the work was taken over by Fuller, who completed some unfinished work and prepared a report. The results may be summarized as follows: A wet swab with excess moisture squeezed out was more effective than a dry or a moist swab for removing bacteria from used drinking glasses. A diluting fluid containing a phosphate (Butterfield's phosphate) was more effective than distilled water or physiological salt solution for preserving the viability of bacteria on swabs when they had to be held for some time before plates were made. When swabs had to be held for several hours before plates were made, it was found that chilling the containers with ice helped materially in preventing loss of viability of the bacteria. A yeast-dextrose medium similar to that used for the Standard-Methods procedure for plating milk samples gave good recovery of bacteria for swabs. Practical examinations were made of local establishments serving food and drink.

Bacteriological Study of Chocolate Milk. (James E. Fuller and R. W. Swanson, in cooperation with W. S. Mueller of the Department of Dairy Industry.) This study has been completed and the results published. They may be summarized as follows: The addition of chocolate syrups or cocoa powders inhibited the growth of bacteria as compared with growth in the milk without the powders or syrups. Even though the bacterial content of some of the powders and syrups was high, the resultant growth of bacteria in chocolate milk made from these powders or syrups was not nearly as great as was anticipated. Experiments indicated that the tannic substances in the chocolate or cocoa were responsible for the inhibition of bacterial growth.

Bacteriological Studies of Rural Water Supplies. (James E. Fuller.) This project has been started within the year. Some preliminary work along this line has already been reported (James E. Fuller and Sonnia Levine, Mass. Agr. Exp. Sta. Bul. 378, 1941). Present experiments are being done on an amplified scale. The study aims to attempt a differentiation of the intermediate members of the coliform group of bacteria, so frequently encountered in rural water supplies (wells or springs), to learn how many of them indicate serious pollution and how many indicate merely surface wash. The differential reactions (Imvic tests) of these bacteria are being studied at several incubation temperatures, from room temperature to 46°C. (Eijkmann-test temperature), to determine the proportion that are related to the fecal *Escherichia coli*. Present indications are that the use of the Eijkmann-test temperature for incubating the Imvic tests may be useful in evaluating the sanitary quality of rural water supplies.

Laboratory Service. (R. L. France, until July 1942; James E. Fuller, beginning July).

Milk (bacteria counts)	392
Ice cream (bacteria counts)	91
Milk (butter fat)	27
Water	107
Miscellaneous	3

DEPARTMENT OF BOTANY

A. Vincent Osmun in Charge

Diseases of Trees in Massachusetts. (M. A. McKenzie and A. Vincent Osmun.)

The Dutch Elm Disease Problem. The Dutch elm disease caused by the fungus, *Ceratostomella ulmi* (Schwarz) Buisman, and spread by bark beetles was found in Massachusetts in 1941. During 1942, investigation of this disease in the State has had three main objectives: the discovery and eradication of diseased trees; the evaluation of the importance of woodpiles as sources of the causal fungus and carrier beetles; and the elimination of conditions favorable to the spread of the disease.

Results of the inoculation of several species of elm with the causal fungus in early summer under controlled conditions in the greenhouse indicate that all species of elm are susceptible; but American elm (*Ulmus americana* L.) showed symptoms of the disease most promptly and succumbed most rapidly of all species, potted plants of the species being completely killed within 10 days after inoculation. Death presumably is due to a toxin produced by the fungus, but the word "toxin" is here employed only in a nonspecific sense. Studies previously reported by others, as well as the writers' investigations, indicate that microscopic symptoms indistinguishable from those resulting from fungus infection may occur in plants variously treated with sterilized extracts from fungus cultures. If the symptoms are associated with a specific toxin, a neutralizing agent may be found, although no consistently reliable agent has been found by the writers.

Considerable interest in the work has been shown by municipal tree departments and private citizens, and many specimens for laboratory study were received during the past year. Through the cooperation of the United States Bureau of Entomology and Plant Quarantine, valuable information relative to the general distribution of the disease has been obtained regularly. Seven diseased trees have been eradicated in Massachusetts: in 1941, 1 in Alford; in 1942, 3 in Egremont, 1 in Great Barrington, 1 in Westfield, and 1 in Sheffield. The

eradication of diseased trees is under the direction of the State Department of Agriculture which has cooperated also in the entire program. The infection of trees in the southwestern part of Berkshire County and Westfield, Massachusetts, apparently does not indicate direct spread of the disease between these two regions within the State, but rather the introduction of the disease into the State at two separate points, presumably from a common source in the extension of the infestation radiating from the area around New York City.

In order to protect disease-free elms, concerted effort has been directed toward the elimination of freshly cut elm wood. At present this procedure is the most practical control that can be employed effectively in checking the spread of the disease. Since the disease fungus is virtually a prisoner within an affected tree, it cannot spread significantly except as it is carried from a diseased to an uninfected tree by a vector. The best evidence indicates that the smaller European elm bark beetle, *Scolytus multistriatus* Marsh., is the principal carrier insect. This insect invades the bark of weakened trees or freshly cut elm wood, where eggs are laid in galleries engraved between the bark and wood. Upon emergence, the beetles feed on healthy elm twigs and in this manner may facilitate fungus infection of healthy trees if the feeding beetles come from galleries in diseased wood. The beetle is now known to occur in Springfield, West Springfield, and Westfield in Hampden County, and widely in Berkshire County, in addition to the originally known eastern Massachusetts section of infestation which has been enlarged to include most of the area east of Worcester County.

The prompt destruction by burning of all freshly cut elm wood which is well suited for infestation by bark beetles is urged upon all agencies and individuals whose work brings them into contact with it, unless there is complete assurance that the bark will be removed immediately after the wood is cut or other provision is made for the consumption of any fungus-free wood as fuel in cooperative agreements. Tree wardens, foresters, arborists, fire wardens, highway departments, state departments, and public utilities have cooperated generously in aiding in this practical method of protecting disease-free elms. As in the case of all diseases of plants, however, unbroken continuity of the program is most essential.

Other Tree Problems. Sixty-three diseases of thirty-four species of trees, including nine diseases of elm, were identified from approximately 300 specimens and inquiries received during the year. The Cephalosporium wilt of elm was reported from 4 municipalities in which no previous cases of the disease had been reported, making a total of 177 cities and towns in which the disease has been found in Massachusetts. The fungus, *Verticillium* sp., was isolated from several species of woody plants, but no specimens were received from municipalities not included in the total of 96 reported for 1941.

Following an extended period of wet weather early in the growing season, leaf-inhabiting fungi caused considerable damage to foliage. Trees throughout Massachusetts were affected.

A nonparasitic disease of white pine, commonly known as needle-blight, in which needles of the current season discolor to varying degrees beginning near the tips, was rather prevalent both on ornamental trees and in plantations.

At the request of the Massachusetts Tree Wardens' and Foresters' Association, a report on wartime municipal tree programs was prepared, and subsequently a survey of tree diseases and other defects was made, with a view to outlining a program for tree protection and the prevention of damage by defective trees to persons and property. Current miscellaneous activities included the preparation of parts of the program of the annual Five-day Short Course for Tree Wardens, the compilation of a progress report, revision and publication of a manuscript on a Peridermium of northern hard pines, the discussion of the control of wood-

destroying fungi at the Eastern Pest Control Operators' Conference, the preparation of a mimeographed circular on "Trees in War," and the writing of newspaper press releases. Publications referred to are found listed at the end of this bulletin.

Damping-off and Growth of Seedlings and Cuttings of Woody Plants as Affected by Soil Treatments and Modification of Environment. (W. L. Doran.) As a result of increasing interest in the beach plum, a native plant heretofore relatively neglected, work is now being done in cooperation with J. S. Bailey of the Department of Pomology on its vegetative propagation, and an article on the subject was recently published. There was no rooting of hardwood stem cuttings, but softwood cuttings rooted fairly well and best (67 percent in 25 days) when taken here in mid-June and treated with indolebutyric acid (50 mg./l., 24 hr.). Work with root cuttings taken in the fall is now in progress.

The vegetative propagation of garden sage, a plant not now available to spice manufacturers from the usual European sources, was investigated in cooperation with A. M. Davis of the Division of Horticulture, and an article published. Untreated cuttings taken in winter rooted well in sand–peat or sandy soil, better than in sand; but their rooting was hastened or improved by treatment for 24 hours with naphthaleneacetic acid or indolebutyric acid 25 mg./l.

None of the treatments (red cuprous oxide, Barbak D, zinc oxide, Spergon, and Semesan) which were applied to seeds of trees sown in a cold frame in March gave wholly satisfactory protection against infection of seedlings by soil fungi. So far as there were differences in final stands, they were in favor of the use of red cuprous oxide with blue spruce, Barbak D with white pine, and zinc oxide with hemlock, arbor-vitae, Douglas fir, and sycamore.

In propagation by cuttings, it is important to know which species need no treatments with root-inducing substances. It is noteworthy, therefore, that August cuttings of *Actinidia arguta* and February cuttings of *Decaisnea Fargesii*, both of which bear edible fruit, also February cuttings of *Viburnum rhytidophyllum*, rooted 100 percent without treatment.

Cuttings of Norway spruce are not very responsive to treatment with the commonly used root-inducing acids. But the rooting of February cuttings of two varieties, *pygmaea* and *nana*, was hastened and improved by treatments with solutions of manganese sulfate, 1.0 percent and 5 hours for the former, 0.5 percent and 24 hours for the latter. Rooting of late fall or early winter cuttings of Norway spruce, variety *nana*, as well as cuttings of black spruce, yew, and Hinoki cypress was also improved or hastened by treatment with monobasic potassium phosphate 0.5 percent, 20 hours. Rooting of the last named was more improved by this treatment than by indolebutyric acid.

A mixture of sand and European sphagnum peat has been favored as a rooting medium, but an American sedge peat, similarly used, may give better results. January cuttings of *Lonicera syringantha*, treated with indolebutyric acid 50 mg./l., 24 hr., rooted 92 percent in a mixture (2:1) of sand and Florida sedge peat, decidedly less well in a similar mixture of sand and European sphagnum peat.

To determine the possible effect of a powder-dip treatment in combination with and immediately after solution-immersion treatments, cuttings of Chinese juniper (the variety *torulosa*) taken in February were variously treated. Untreated cuttings rooted only 11 percent. There was 83 percent rooting of cuttings treated with Hormodin No. 3 after treatment for 20 hours with indolebutyric acid 50 mg./l. or naphthaleneacetic acid 25mg./l., while cuttings given only the solution treatments rooted not more than 50 percent.

As compared with our knowledge of soil disinfection prior to seeding, there has been relatively little information available about the disinfection of rooting media for cuttings. When a rooting medium, sand–peat, was disinfected by

steaming, by formaldehyde, or by vinegar within 24 hours before the insertion of winter cuttings, there was injury to arbor-vitae, red cedar, Hinoki cypress, yew, and two species of Ilex. Similar treatment of the rooting medium with steam or formaldehyde four days before the insertion of cuttings was also harmful or of no benefit. Such treatments are apparently more toxic to cuttings, even dormant cuttings, than to some seeds and it is evident that there should be considerable delay between the disinfection of a rooting medium and the planting of cuttings.

Cuttings of white pine, made of the previous year's growth, were taken in late winter. They rooted neither more nor less well in sand–peat previously used for this purpose, or in sand–peat to which soil from under pine trees had been added, than they did in new sand–peat, never before used, or in new sand–peat steam-sterilized fifteen days previously. Fungi in the rooting medium are, it appears from this, without effect on the rooting of cuttings of white pine. Cuttings from different white pine trees differ in rooting capacity, and treatments which improve the rooting of cuttings from some trees are without much or any effect on the rooting of cuttings from others. Rooting of cuttings from some trees was improved by relatively short solution-immersion treatments in relatively concentrated indolebutyric acid or napthaleneacetic acid solutions, by powder-dip treatments with Hormodins No. 2 and No. 3, and by combinations of solution-immersion and powder-dip treatments.

Effect of Chromated Zinc Chloride on Plants. (L. H. Jones.) The scarcity of lumber which is naturally decay-resistant has led to the use of a chemically treated substitute. This has been successful in the case of telephone poles, railroad ties, building supports, etc. However, when such chemically treated lumber was used in the construction of benches in which plants are grown in the greenhouse, results have indicated that the wood preservative may be toxic to the plants, instead of only to the fungi and bacteria which cause decay.

In tests made here, where chromated zinc chloride was used as the preservative, injury to growing plants was very common and was most pronounced during the warmer months and with the more acid soils.

Study of Diseases of Plants Caused by Soil-Infesting Organisms, with Particular Attention to Control Measures. (W. L. Doran.) Seed treatment with a mixture of oxyquinoline sulfate and talc (1:1) markedly improved stands, but seed treatment with a mixture of potassium dichromate and graphite (1:1) gave even better results; as good results, in fact, as did Semesan, Spergon, or red copper oxide with cucumber, cress, beet, tomato, and chicory. Only with pea did Spergon give better results than potassium dichromate. With tobacco, red copper oxide as a seed treatment gave the best results, Spergon the poorest; but none of the seed treatments gave as good results as did formaldehyde treatment of soil.

Sodium nitrite, 1.5 to 3.0 gm. per square foot, applied to soil immediately after seeding, was injurious to crucifers and to pea, not to cucumber, beet, and chard, and it markedly increased the number of plants which lived. Lacking anything better, it could be used as a soil fungicide with some plants, but it did not give as good results as did much lighter applications of potassium dichromate.

Chromates and dichromates of potassium, ammonium, and sodium, applied as solution to soil immediately after seeding, were found to be highly effective soil fungicides, as effective as formaldehyde even in light applications. And, if properly used, they were quite safe as regards effects on germination and growth of seedlings, except with cabbage and other crucifers. Potassium dichromate, 0.4 to 0.45 gm. per square foot (about 43 pounds per acre), was usually enough for protection and great improvement in the stands of seedlings whether the pH value

growth in the acid than in the slightly alkaline soil. Dichromates usually gave somewhat more complete protection and, if used in unnecessarily heavy applications, retarded growth of seedlings more than did the chromates. But if applied at the time of seeding and at the rate of not more than 0.45 gm. per square foot, the chromates and dichromates of potassium, sodium, and ammonium were without ill effect on cucumber, beet, chard, pea, and bean; and the chromates of potassium and ammonium, especially the latter, gave very good results. Potassium dichromate was most effective and safe when applied to soil immediately after seeding. Applied 24 hours later, it retarded germination of seeds of some species. It gave satisfactory control when applied to soil two weeks before seeding but was less effective when applied more than three weeks before seeding. Chromate and dichromate of potassium, as used, gave more complete protection than did the corresponding salts of sodium. Chromic acid gave superior results only with beet; and the chloride, nitrate, and sulfate of chromium were almost completely ineffective.

Cresol, in as light an application as 1.5 cc. per square foot, immediately after seeding, gave good control, almost as good as did formaldehyde.

A very light application of formaldehyde (4.9 cc. or one teaspoonful per gallon of water) was most effective when applied to soil immediately after seeding, decidedly less effective when applied more than 24 hours after seeding. Growth of beet, cucumber, and lettuce was improved by applications made not more than 8 hours after seeding, but seedlings of pea were injured when the first application was made 24 hours after seeding.

When nutrients in the form of potassium nitrate and precipitated bone or Ammo-Phos were added to a solution of formaldehyde and applied to soil at the time of seeding, the fungicidal action of the formaldehyde was unimpaired. But in a good sandy loam, the growth of seedlings of pepper, eggplant, beet, and cucumber was improved as much by formaldehyde alone as by formaldehyde plus the nutrients.

Starter solutions applied to the soil around tomato plants as they are set in the field cannot, without danger of chemical injury to the plants, carry enough formaldehyde to be effective against soil fungi.

Lacking chemicals, seeds of some kinds, not all, may well be sown on a layer of sphagnum, overlying soil. Damping-off was well controlled in this way, although not so completely as by formaldehyde treatment of soil. Sphagnum so used gave good results with lettuce, cabbage, and cress, the two latter being especially susceptible to injury by formaldehyde; but sphagnum did not give good results as regards either stands or growth of the solanaceous plants, pepper, eggplant, and tobacco.

Chemical Soil Surface Treatments in Hotbeds for Controlling Damping-off of Early Forcing Vegetables. (W. L. Doran, E. F. Guba, and C. J. Gilgut.) This study was completed with the publication of Bulletin 394.

In some additional tests, certain newer chemical materials offered as seed protectants, notably Spergon, Thiosan, yellow cuprous oxide, and tri-basic copper sulfate, showed in many instances value equal to or surpassing Semesan, red cuprous oxide, and zinc oxide on a wide variety of flower and vegetable seeds.

Control of Greenhouse Vegetable Diseases. (E. F. Guba, Waltham.) The various types of tomatoes studied for their reaction to Alternaria early blight were also tested for their susceptibility to Cladosporium leaf mold. Among them seven types were found showing a very slight degree of susceptibility indicated by sparse, yellowish areas without sporulation, molding, or necrosis, and one type showing none of these symptoms and from all appearances immune. In addition,

all six selections of *Lycopersicon peruvianum* (L.) Mill. showed a similar type of immunity. Bulletin 393 embodies the progress and results of several years' work in the development of resistance in tomatoes to Cladosporium. The Bay State variety is showing susceptibility to the new strain of Cladosporium in an increasing number of greenhouses. Nevertheless, many growers have accepted the new variety as a choice forcing tomato. Now that resistance to the new or Bay State strain of Cladosporium has been found, it is being utilized in an effort to combine resistance with desirable commercial type.

Resistance to Tomato Alternaria Early Blight. (E. F. Guba and R. E. Young, Waltham.) Seed of some 37 elementary types of tomatoes offered as possessing significant resistance to *Alternaria solani* (E. & M.) Jones & Grout were secured for trials at Waltham. These tests were purely exploratory, and if suitable resistance appeared, it was the intention to utilize it for breeding purposes in the development of a blight-resistant tomato. Since a large volume of copper fungicides is employed in the control of tomato early blight, this study would appear to represent a worthy contribution to the war effort.

Weather conditions were ideal for the development of early blight, but in spite of repeated artificial inoculations the disease rather consistently became epidemic only in correlation with a heavy load of fruit and maturity of the fruit. Thus many types remained relatively free of the disease until late in the season and then showed it in severe proportions. The largest and heaviest fruited and earliest maturing types consistently showed a high degree of susceptibility, and only nine types showed resistance.

Interrelation of Wettable Sulfur, Lead Arsenate, and Lime in Apple Spraying. (Departments of Botany, Chemistry, Entomology, and Pomology cooperating.) This project is intended to add to our knowledge of insect and disease control and to assist in making improvements in the apple spraying schedule. On this basis special consideration was given to tenacity of sulfur, scab control, spray injury, and insect control.

Disease Resistance and Heredity of Carnations. (E. F. Guba cooperating with H. E. White, Waltham.) Eighteen varieties of carnations were scrutinized for their susceptibility to various important fungus diseases. As was to be expected, in view of the wide host range of *Rhizoctonia solani*, no resistance to this fungus was found.

Twenty-two varieties were studied for their reaction to *Alternaria dianthi* (blight). Virginia, New Deal Ward, Minna Brenner, and Hazel Draper showed a moderate to high degree of susceptibility, but not until long after the benching season. The disease has become increasingly insignificant in recent years.

A high degree of susceptibility to Uromyces rust was shown by Woburn, Olivette, New Deal Ward, Hazel Draper, Paragon, Pink Treasure, Johnson's Crimson, Spectrum Supreme and King Cardinal.

Tests with the branch rot organism, *Fusarium dianthi*, and the root rot organisms, *F. avenaceum* and *F. culmorum*, yielded no results.

Effect of Soil Temperature on Timothy (Phleum pratense L.). (L. H. Jones.) Seedling plants of timothy were transplanted to containers of soil at a high level of fertility. The plants were allowed to establish themselves at a soil temperature of 65° F., after which the apparatus was adjusted to a range of soil temperatures from 50° to 90° at 10-degree intervals. Tiller counts at 50 days showed that soil temperature affected stooling, the number being greater at 70° and tapering off to the extremes of 50° and 90°. At 50° there was a marked tendency for the shoots to be prostrate in habit. This prostrate habit was also noted in a cool greenhouse

with brome grass (*Bromus inermis* Leyss.), meadow fescue (*Festuca elatior* L.), perennial rye grass (*Lolium perenne* L.), and timothy (*Phleum pratense* L.).

The number of tillers was closely associated with the height of the plants, those at 70° F. being the tallest at 50 days. Foliage and stem color were affected by soil temperature. The plants at 50° were a dark green, and those at 60° were intermediate between the dark green at 50° and the light green at 70° and above.

There were enough replications so that half the containers were available for shifting of temperatures, the remaining half being kept at the same temperature as at the start of the test. The shifted temperatures were 20 degrees higher or lower than the original temperatures. By this means it was possible to corroborate the earlier conclusions made at the 50-day period. Plants which had been at 50° F. and were dark green, prostrate in habit, short, and with few tillers, responded soon to the 70° soil temperature by assuming the characteristics of the check at 70°. On the other hand, the plants at 70°, when shifted to 50°, became prostrate in habit, dark green in color, and stopped growing. At temperatures of 80° and 90°, the check plants and those shifted from 60° and 70° were not in a healthy state of activity; but the unhealthy plants shifted from 90° to 70° and from 80° to 60° resumed the healthy appearance of the check plants for these temperatures.

In the final stages, the plants at 90° F. soil temperature were very poor. Several had died and the remainder were stunted and dark green in color. The plants at 50° and 60° had the most and tallest spikes, but the foliage at the base was sparse. The plants at 70° had thick foliage at the base indicating continued vegetative activity. These plants also had the greatest dry weight. It also appears that soil temperatures lower than 70° give greater dry weights than those above 70°. Since careful attention was given to supplying water, the experiment indicates that soil temperature is the governing factor, and not drought, which is frequently associated with long hot spells of weather.

DEPARTMENT OF CHEMISTRY

Walter S. Ritchie in Charge

Chemical Investigations of the Onion. (Emmett Bennett.) The preliminary work on the characterization of the soluble carbohydrates of the Ebenezer onion as reported last year has been extended. The titration of the hydrolyzed sugars with standard iodine and alkali and the determination of the fructose both indicate that the total sugars are approximately two-thirds d-fructose. Syrups of the total hydrolyzed sugars yielded crystals with a specific rotation of $[-41°]_{D.}^{20}$ which is of the order expected for a mixture of d-glucose and d-fructose in the ratio of 1 to 2.

By removal of the reducing sugars, a preparation was obtained having a specific rotation of about $[+48°]_{D.}^{20}$ and after inversion about $[-17°]_{D.}^{20}$. This, together with the large negative enhancement noted on solutions after inversion, is a strong indication that the chief non-reducing sugar is sucrose.

The present work is concerned with metabolic changes which occur in the cell during growth. Samples were taken at intervals during the growing season. At mid-season onions were collected and divided into equal groups, some of which were placed in total darkness for different periods of time. The many forms of nitrogen have been determined as well as the sulfur compounds, organic acids, and carbohydrates.

Some of the chemical changes during normal growth are as follows: Total nitrogen and organic acids decreased as the season progressed; soluble nitrogen and total sugars increased. The increase in total sugars continued until the middle of the season. Up to that time the trend was the same for both reducing and non-reducing sugars; thereafter the main change appeared to be the formation of non-reducing sugars.

The results of the culture work in complete darkness are almost completely opposite those of the control. In darkness the content of solids, total nitrogen, water soluble nitrogen, organic acids, and carbohydrates decreased gradually.

The Hemicelluloses of Forage Plants. (Emmett Bennett.) Previous work at this station has indicated that a considerable difference exists in the content of moisture of forage grasses. An investigation of the polyuronide hemicelluloses of two species, sheep's fescue (*Festuca ovina*) and sweet vernal (*Anthoxanthum odoratum*) which represent grasses of low and high moisture content respectively, indicated that this difference may be due chiefly to this group of substances. The greater content of total hemicelluloses was found in the low-moisture grass, and the nature of these groups in the two species was quite different.

The hemicelluloses of each species, when hydrolyzed, yielded mainly a uronic acid, l-arabinose and d-xylose in the approximate molar ratio of 1:0.2:15.7 in sheep's fescue and 1:2.9:9.3 in sweet vernal. A preliminary examination of the viscosity of the hemicelluloses indicated that those from sweet vernal grass when dispersed in water produced not only the more viscous system, but also the more stable system. Those from the sheep's fescue for the same period and under the same conditions were almost completely flocculated. It would appear, therefore, that the degree of hydration of the two products differs considerably, and that the species containing the more highly hydrated product has the greater original moisture content and contains the larger percentage of l-arabinose.

Lignin and Its Relation to Absorption of Minerals by Plants. (Emmett Bennett.) Special attention has centered around the mobilizing power of isolated lignin as a representative of the residual organic matter in the soil. While it is known that organic matter may absorb free ions in the soil, its role as a mobilizer of ions is not so well established. To determine the possibilities of lignin in this capacity, a container was devised which would hold both the inorganic material (calcite) and the suspension of lignin in contact with each other and allow the suspension to be agitated with a power driven stirrer, to renew the contact, without disturbing the calcite. The lignin was freed from mineral acids by electrodialysis. The extent of mobilization could be noted from time to time by the losses in the weight of calcite. Calculations based upon such a procedure indicated that mobilization did take place over a period of several months in amounts equivalent to a base exchange capacity of about 175 milli-equivalents per 100 grams of lignin. This phenomenon indicates that the residual organic matter as such may mobilize ions from insoluble compounds. A practical application may be in the form of contact depletion.

On the assumption that the high base exchange values of soil organic matter are due to previous oxidations, samples of lignin were oxidized by iodine. Iodoform was obtained as one by-product. The oxidation value amounted to 175 ml. of N/10 iodine per gram of lignin. Base exchange values of the oxidized lignin were about 35 percent higher than those of the control.

Attempts were made to determine the nature of the functional groups most active in base exchange activity by blocking the aromatic hydroxyl group with acetyl groups. This, while not wholly satisfactory, indicated that the hydroxyl groups were chiefly responsible.

Chemical Changes in Cooking Quality of Vegetables. (Monroe E. Freeman.) A quantitative method for measuring the texture of baked potato tissue by estimating the pore space of dried slices was found to be satisfactory. The method was applied to the study of texture changes in tubers during winter storage. Samples stored at 35° and 50° F. for 76 days, 130 days, and 161 days were baked and the texture was measured or estimated by three methods. Center rot and "blackening" appeared in so many tubers that conclusive results were not obtained. From the sound samples available, however, there seemed to be very little change in specific gravity during the storage period. A visual scoring method indicated that the cooking quality, i.e., texture, was lower in tubers stored for longer periods and at the lower temperature. Toluene index of the tubers indicated a small decrease in baking quality with time of storage at the higher temperature, but because the samples were incomplete these results cannot be assessed with any certainity.

Physico-Chemical Properties of Starches. (Monroe E. Freeman.) The anomolous heat capacities of starch-water systems reported in 1941 were carefully studied and applied to dextrin-water systems and to sand and water. The data allowed a clear explanation of the phenomenon and its relation to the bound water in lyophillic colloids and indicated the existence of a general phenomenon of lyophillic systems that hitherto has not been clearly recognized.

The Influence of Base Exchange Capacity and of Exchangeable Ions in Massachusetts Soils on the Availability of Potassium. (Dale H. Sieling.) Pot cultures of synthetic soil for plant growth were prepared by mixing quantities of a typical tobacco soil, the Agawam fine sandy loam, with electrodialyzed bentonite which had been adjusted to fixed calcium levels with calcium hydroxide. These cultures were all of the same reaction and varied considerably in their base exchange capacity. Four levels of base exchange capacity, 7.1, 12.0, 17.0, and 22.0 milliequivalents per 100 grams, were established. At each base exchange capacity level the soils were fertilized with four different quantities of potassium and with a fixed quantity of both phosphorus and nitrogen. Nitrogen was also added at various times during the growth of the plants. Each culture was prepared in duplicate and contained 7000 grams of synthetic soil. Tobacco, Havana Seed 211, was used to test growth response and nutrient uptake. One plant was grown in each culture and the soils were watered with distilled water whenever the rainfall was inadequate.

Luxuriant growth was obtained in all cultures and there were no apparent nutrient deficiencies or excesses. Growth, as indicated by the dry weight of the plants, was increased very little by addition of gypsum. The cultures having an exchange capacity of 17.0 milli-equivalents gave plants of the highest average weight. There was a tendency for the dry weight of plants to increase as the quantity of potassium increased at each exchange capacity level.

The Fixation of Arsenic in Soils and the Influence of Arsenic Compounds on the Liberation of Fixed Phosphate. (Dale H. Sieling.) Very marked differences in sorption of phosphate and arsenate were observed when ballmilled Kaolin was used as the sorption substance. When 1-gram samples of ballmilled Kaolin were shaken for two days with increasing quantities of sodium arsenate at pH 3.0 in 10 ml. of solution, there was a linear increase in the arsenate sorption up to about 13.0 milli-equivalents per gram for a solution having 42.5 milli-equivalents. At higher concentrations there was a sharp increase in the amount of arsenate sorbed followed by progressively smaller increases in the pattern of a typical adsorption. When 1-gram samples of Kaolin were shaken for seven days with solutions of the same concentrations, instead of for two days, the sorption

followed an entirely different pattern. As the concentration increased, the sorption followed a smooth curve until 12.3 milli-equivalents per gram were sorbed from a solution containing 40.0 milli-equivalents. As the concentration increased above this point, there was a marked decrease in the sorption of the arsenate and also a considerable increase in the volume of Kaolin (from 1.7 ml. to 5.0 ml. per gram). The amount of arsenate sorbed remained constant at 10.8 milli-equivalents per gram between the concentrations of 40 and 50 milli-equivalents per 10 ml. of solution and then increased rapidly in a true adsorption pattern up to 24.1 milli-equivalents for a solution containing 80 milli-equivalents of arsenate ion. It seems likely that both arsenate and water are sorbed by the Kaolin and at the critical concentration of 40 to 50 milli-equivalents per gram, the water is sorbed more, thus causing the tremendous increase in volume of clay and making it appear as though arsenate were not being adsorbed when one uses the solution concentration as an index of the sorption.

The same type of experiment was made with phosphate solutions and a typical adsorption curve was obtained for this ion. No apparent increase in volume was noticed at any concentration of phosphate and the maximum sorption was found to be about 12.4 milli-equivalents of phosphate per gram of Kaolin. This ion apparently does not have the marked hydrating effect exhibited by the arsenate ion, although it is sorbed in considerable quantity.

The Effect of Orchard Mulches on the Plant Nutrient Elements in the Soil. (Dale H. Sieling and J. K. Shaw.) Three test plots were established in the summer of 1941 to determine whether mulching with hay and glass wool had any effect on the mobilization of the plant nutrient elements of orchard soils. One plot received a two-inch mulch of Fiberglass wool, the second received a liberal application of meadow hay, and the third was surface-cultivated to prevent the growth of weeds. One year after the initiation of the experiment soil samples were obtained from four depths in each of the test plots and analyzed for exchangeable bases and available phosphorus. No material change had taken place in the plant food content of the soils at any depth after one year of the treatments. These results were to be expected since there had been very little decomposition of the hay mulch. More hay has been added to the plots which are to receive hay mulch and samples will be taken for analysis from all of the plots again next year.

CONTROL SERVICES

P. H. Smith in Charge

The fertilizer, feed, seed, and dairy laws are administered as one service and the operations of each of these, with the exception of the dairy law, are completely reported in annual bulletins issued for that purpose.

Besides the regular control activities the laboratory, through its staff, cooperates liberally on numerous research projects active in other departments and also performs many analytical and testing services for State institutions and for private citizens who, because of the nature of their problems, deserve this consideration.

Under the dairy law 5,984 pieces of Babcock glassware were tested and 107 Certificates of Proficiency were issued during the year ending December 1, 1942.

The enlarged emphasis on the vitamin values of all feeds, and commercial feeds in particular, and the increased interest in the manganese content of poultry mashes and in the protein quality of meat and fish products used for feed demands

continual expansion of the analytical service in those fields and, in an attempt to define these values, several special circulars were published during the year in order that the feeder might extend intelligent and deserved consideration to these recently recognized beneficial factors in feed products.

THE CRANBERRY STATION

East Wareham, Massachusetts—H. J. Franklin in Charge

The season's cranberry crop was the second largest in the history of the industry, both in Massachusetts and in the United States. There was rather more rot among the berries as they came from the field in this State than has been evident in any other year, and the abnormal decay showed a marked tendency to continue in storage. Fortunately, a lively demand for the berries throughout the selling season, both for commercial canning and as fresh fruit, moved the crop promptly.

Injurious and Beneficial Insects Affecting the Cranberry. (H. J. Franklin.)

Hill Fireworm (*Tlascala finitella* (Walker)). Moths of this species emerged in confinement very late in May and were caged with cranberry branches on May 30. On June 13 many small caterpillars were found to have hatched from eggs that had been laid during the interval. Some of these were as much as a twelfth of an inch long and had done considerable feeding, so they may have been three days old, indicating that the eggs hatch about ten days after they are laid. Some unhatched eggs were found, most of them on the stems of the new cranberry growth. They were oval in outline, much flattened against their support, and about a fortieth of an inch long. The young worms had blackish heads and very faintly striped reddish brown bodies.

The Burrage bog, infested with this insect last year, was examined on June 16. The worms there had channeled some of the cranberry stems toward and to the tips causing them to drop over. Occasional worms, already showing their striping were sewed up in the cranberry tips like black-headed fireworms, but with more frass around them. The infestation on this bog was again quite serious.

Spotted Fireworm (*Cacoecia parallela* (Rob.)). This pest broke out severely on about nine acres of bog in Marion, Mass., early in June. Most of the worms matured by July 8, but some remained till after July 16 when the moths had begun to fly. The infestation was well controlled by dusting with 30 pounds of cryolite to an acre on June 25.

Nine species of parasites were reared from this pest, the most prevalent being *Itoplectis conquisitor* (Say), of the order Hymenoptera, family Ichneumonidae; and *Nemorilla floralis* (Fallen), of the order Diptera, family Exoristidae. All the others belonged to the order Hymenoptera, four being Ichneumonidae and three Chalcidoidea.

The spotted fireworms fed on the following weeds on and around the infested bog: chain fern, sensitive fern, marsh shield fern, common brake, flowering fern, saw brier, hardhack, chokeberry, coarse bramble, winterberry, marsh St.-John's-wort, sweet pepperbush, swamp blueberry, sheep laurel, loosestrife, and asters. Loosestrife and marsh St.-John's-wort were evidently favorite food plants of the insect. They were very abundant on the bog and may have largely induced the infestation.

Some pupae of the spotted fireworm squirm vigorously when disturbed, but they are more often inactive. Each of the abdominal segments of the pupa, except those toward the posterior end, has two ridges across the upper surface

with the surface between them very smooth, each ridge bearing a single row of many short, sharp, tooth-like spines pointing obliquely backward.

White Grub (*Phyllophaga*). Young grubs, evidently hatched in June, were found rather abundant in a small area on the station bog on July 13, 1942. They were quite active and all within an inch or two of the soil surface, most of them within an inch of it.

Cranberry Spittle Insect (*Clastoptera*). The young nymphs in their spittle were found as early as June 2. Flooding a bog for 24 hours as soon as an occasional flower had opened wiped out a heavy infestation completely without harm to the vines or crop. This seems to be an excellent treatment.

Cranberry Root Grub (*Amphicoma*). Half of the station bog was treated with seven ounces of sodium cyanide in 100 gallons of water, a gallon to a square foot, late in April and very early in May. The treatment was very successful and did not reduce the crop. It hurt the vines only on a few small areas. Flood water drained from this bog eight days after the application had no poisonous effect.

Army worms (*Leucania*) attacked freely several bogs that had been flooded from mid-May to mid-July to control the root grub.

Grape Anomala (*Anomala lucicola* Fab., formerly reported as *Anomala errans*). Five acres of seriously infested bog, located in the Wenham section of Carver and not heretofore known to be affected by this grub, were treated very successfully with sodium cyanide solution.

Cranberry Tolerance of Certain Materials. Long experience has found cranberry vines very intolerant of sulfur but very tolerant of kerosene and fairly so of copper.

Cryolite, four tons to an acre, was applied to small areas of the station bog on June 20, 1941. Injury from this was very slow in developing but had become severe by July 1942.

A mixture of 4 pounds of calomel and 96 pounds of talc, 100 pounds to an acre, was dusted onto plots of Howes vines on July 1, 1941, with the vines then approaching full bloom. The set of fruit and size of berries were not much affected, the crop turning out to be about as abundant as on the bog around the plots; but the treatment greatly delayed the ripening of the berries and they finally failed to develop a good red color. The berries were picked toward the end of September and were examined chemically and spectroscopically for mercury, but none was found. The vines on these plots were not quite so green in the fall of 1941 as those on the bog around them, and a rather noticeable number of scattered branches died. The treated areas had a normal appearance during the 1942 growing season, but they bore only about a third as much fruit as areas of the same size around them.

Prevalence of Cranberry Insects in 1942.

1. Bumblebees and honeybees were abundant everywhere on Massachusetts bogs during the cranberry flowering.
2. Infestation by Gypsy Moth (*Porthetria*) was light in Plymouth County and moderate on most of the outer Cape.
3. Cranberry fruit worm (*Mineola*) was about normally abundant, more so than in 1941.
4. Black-headed fireworm was normally abundant, more so than in 1941.
5. Firebeetle (*Cryptocephalus*), almost none.
6. Yellow-headed fireworm (*Peronea*) was more troublesome than usual in recent years.

7. Spotted fireworm was generally more abundant than for many years.
8. Lady beetles were unusually prevalent.
9. False armyworm (*Xylena*) was very prevalent, about as in 1941.
10. Blossom worm (*Epiglaea*) was much less than normally abundant.
11. Spanworms were about as usual.
12. Cranberry girdler (*Crambus*) was more harmful than normal.
13. Cranberry weevil (*Anthonomus*) was about as in other recent years.
14. Cranberry spittle insect and tipworm were fully as troublesome as usual.

Control of Cranberry Bog Weeds. (Chester E. Cross.) In all, 155 plots were used during the season to test the value of various herbicides. The more interesting results follow:

Kainit. This potash fertilizer has been advocated as an herbicide for poison ivy and has been used extensively in Europe to destroy charlock and wild mustard in plantings of spring cereals. Results with 56 plots to test its value as a cranberry bog herbicide were not encouraging. No injury to either cranberry vines or weeds followed its use in amounts up to 1000 pounds an acre when the foliage was dry; and enough to burn weeds like poison ivy, loosestrife, beggar-ticks, horsetail, or asters with their foliage wet damaged cranberry vines also.

Zotox is widely advertised as a selective weed killer for eradicating crab grass and various broad-leaved perennials from lawns and fairways. Different amounts of solution of this chemical in various concentrations were tried on 46 plots against some of the more common bog weeds. It proved to be valueless as a bog herbicide, not being effective even on crab grass unless enough was used to injure cranberry vines badly.

Ferrous Sulfate. A solution of this chemical[1], a pound to a gallon of water, 400 gallons to an acre, was very effective on low cudweed, with little injury to cranberry vines. This weed is often a serious pest on new plantings and on bogs where grubs have caused areas to be bare of vines.

Kerosene. About 20 plots, on a bog flowed for root grubs till July 15, were treated with kerosene between August 2 and 12. A thick mat of crab grass was almost completely destroyed with 200-300 gallons an acre. The same amount killed barnyard grass, spreading witchgrass, and warty panic grass very effectively. Little harm was done to the relatively tender cranberry vines, most of this injury being on plots treated during the middle of the day or when the vines were wet. The time of day the treatments were made did not affect the killing of the weeds.

Ammonium Sulfamate. Results of dry applications of this new chemical on cranberry bogs have been reported heretofore.[1] This year it was tried in solution as a spray and gave some promise of being a useful herbicide for poison ivy, loosestrife, chokeberry, feather and sensitive ferns, and asters, when used at a rate of not more than one pound in eight gallons of water. Stronger solutions, unless applied in small amount and with great care, were usually very harmful to cranberry vines. Not enough work has been done with this chemical to justify conclusions. It is peculiar that, when cranberry vines have been injured by its use, new growth is slow to develop and its leaves are discolored and undersized, this perhaps indicating that the injury is greater than appears. Partly grown cranberries sprayed with ammonium sulfamate solutions reddened noticeably in a few days without showing other definite signs of injury.

[1] Mass. Agr. Expt. Sta. Bul. 378:47, 1941.

Herbarium. A collection of 140 species of the more common bog weeds has been assembled at the Cranberry Station. It will be useful in identifying weeds for cranberry growers.

Blueberries. (H. J. Franklin.) Only 163 quarts of berries were gathered from the station's cultivated patch in 1942. This small crop is explained by the severe freeze that occurred the night of January 10–11 when the temperature at East Wareham fell to 24° F. below zero, probably the lowest at this place in the last 55 years. The interior of all the fruit buds in the blueberry patch became more or less blackened within a day or two. The subsequent fruiting of the different varieties showed that they varied greatly in their tolerance of the cold:

Adams, Cabot, June, Jersey, and Stanley bore no berries.

Katherine, Pioneer, Rubel, and Wareham produced less than half a crop.

Concord bore half to two-thirds of a crop.

Harding and No. 73 (Station culture number) were reduced only moderately from a full crop. This shows clearly the hardiness of the Harding variety and adds to other great values of No. 73 (a Harding-Rubel cross).

Twenty of twenty-six seedlings of a Harding–Rubel cross developed most of their crop, while 44 of the 59 full-grown miscellaneous plants failed to yield any fruit.

It was finally estimated that the crop of the station blueberry patch, as a whole, was reduced 80 percent by the freeze. However, the blueberry bushes were little injured anywhere by this cold, only the fruit buds and tender tips being hurt, thus evidencing the fact that they approach the wild blueberry in winter hardiness.

DEPARTMENT OF DAIRY INDUSTRY

J. H. Frandsen in Charge

Studies on Chocolate-Flavored Milk. (W. S. Mueller.) The popularity of chocolate-flavored milk has grown greatly in recent years. Whether the addition of the chocolate flavoring enhances or decreases the nutritive value of the milk is a question which has been the subject of much investigation but has not yet been completely answered. The following progress in answering this question has been made.

1. *The Effect of Cocoa Upon the Utilization of the Calcium and Phosphorus of Milk.* (W. S. Mueller, with the cooperation of M. R. Cooney of Home Economics Nutrition.) The presence in cocoa of considerable quantities of oxalic acid suggested the possibility of interference with the utilization of the calcium of the milk or the diet, similar to that observed with spinach, beet greens, and other oxalic acid-rich vegetables. It also seemed advisable to determine whether or not cocoa interfered with the absorption of phosphorus, since milk contains a liberal amount of this important element, which is nutritionally closely associated with calcium. The results from an experiment in which 63 albino rats were used showed that the growth of the rats and their utilization of the calcium and phosphorus of milk were affected adversely by cocoa. It would seem, therefore, that the indiscriminate and excessive use of chocolate-flavored foods, especially in a diet low in calcium, should not be recommended.

2. *Effect of Cocoa on the Vitamin C Content of Milk.* (W. S. Mueller.) The addition of cocoa to milk hastened the destruction of vitamin C. This corroborates the results obtained in a preliminary study.

3. *Vitamin K Content of Cocoa and Dairy Products.* (W. S. Mueller.) It has been observed in the study on the availability of the iron of cocoa that the blood clotting time was shortened when the rats were fed cocoa. This observation led to an investigation of the vitamin K content of cocoa and dairy products. Of the various dairy and cocoa products fed, only cultured buttermilk and cocoa shell had any great effect on blood clotting time. These results indicate that the decrease in blood clotting time, which had been observed for rats receiving cocoa, is not directly tied up with vitamin K.

4. *The Tannic Substances of Commercial Cocoa Powders and the Determination of Cacao Purple.* (W. S. Mueller, with the cooperation of J. W. Kuzmeski.) Commercial cocoa powders have been analyzed for cacao purple by Ulrich's method. The average for 6 Dutch processed samples was 8.44 percent and for 9 unprocessed samples, 12.72 percent. The total ash of the ferric chloride precipitate varied from 11.48 to 18.24 percent. The ash of the precipitate consisted mainly of iron and phosphorus, present either as separate oxides or in combination as ferric phosphate. In general, Ulrich's method for the determination of cacao purple in cocoa products apparently leaves much to be desired. However, the results from this study indicate that the ferric chloride precipitate would measure the cacao purple content more nearly accurately if the washing procedure were modified and a correction made for the ash contained.

Improving the Flavor and Keeping Properties of Milk and Some of its Products. (W. S. Mueller.) Further work is being done on evaluating various substances as antioxidants for butterfat. At the outset of this study, the peroxide test was used in conjunction with the organoleptic tests for determining the effectiveness of the various antioxidants. As the work progressed, it became apparent that the peroxide test was not reliable for replacing organoleptic tests. A new chemical test (Chlorophyll Value Test by M. R. Coe, Eastern Regional Research Laboratory, Philadelphia) is being used for butterfat and seems to correspond more closely to organoleptic rancidity than the peroxide test. Today it is more important than ever before that we know how to prevent spoilage of butterfat because the product is being transported and stored under adverse conditions.

A Study of Vanilla Sugars for Flavoring Ice Cream. (W. S. Mueller.) The high price of grain alcohol is discouraging the use of ordinary vanilla extract for flavoring ice cream. Vanilla sugars appear to be a desirable substitute and their advantages and limitations for use in ice cream are being studied. Sixteen samples, including true, imitation, and mixtures of true and imitation, are being analyzed and used to flavor ice cream. In general, the vanilla sugars were found to be of excellent quality and appeared to be suitable for the purpose, and tests with consumers indicated that it was difficult to distinguish between the true vanilla and the imitation product.

An Explanation of the Increased Efficiency of Gelatin in Ice Cream Mix When Initially Aged at 68°F. (W. S. Mueller.) Results obtained in this study indicate that the initial aging temperature of 68°F. produced a more closely knit gel structure, which has many more inter-connected filaments than a structure produced by aging at the low temperature only. The more numerous gel filaments are effective in obstructing the formation of large ice crystals. This appears to be the most plausible explanation for the smoother texture of gelatin in ice cream when initially aged at 68°F. In view of the present national emergency, it seems particularly timely to emphasize the more effective use of gelatin.

Iodoform Taste in Milk. (H. G. Lindquist.) In a study made on off-flavors in milk, iodoform flavor was detected in a few samples. Investigation showed

that it was traceable to treatment of cows for retained afterbirth by the introduction of oil suspension of boric acid and iodoform into the uterus. One cow so treated secreted enough iodoform in her milk one week after treatment to contaminate 200 gallons of mixed pasteurized milk from the herd.

New Stabilizing Materials for Ice Cream. (A. M. Shipley, M. J. Mack, and J. H. Frandsen.) New stabilizers are constantly appearing on the market and arousing considerable interest because of the uncertainty of the supply of some of the commonly used stabilizers. Algatex, Kragel, Kremtex, and laboratory mixtures of monoglyceride and gelatin and of monoglyceride and Dariloid were compared with gelatin (190 Bloom) and Dariloid as controls, for their effect on ice cream mix and on finished ice cream. The results may be summed up briefly as follows:

1. With the exception of Kremtex, all the stabilizers studied were completely soluble at a temperature of 165°F.

2. Dariloid, Dariloid-monoglyceride, and Kragel were basic in reaction; gelatin, gelatin-monoglyceride, Algatex, and Kremtex were acid.

3. After aging 48 hours, the Algatex mix showed the greatest viscosity; the Dariloid-monoglyceride and Kragel mixes were next; and the gelatin, gelatin-monoglyceride, and Kremtex mixes showed the least.

4. None of the stabilizers affected the titratable acidity of the mix to any marked degree.

5. All except Dariloid, which had the least coagulating effect, affected the protein stability of the mix about the same.

6. All the mixes had about the same whipping rate, with no increase from the use of the particular monoglyceride used in these trials.

7. None of the stabilizers affected the flavor of the ice cream adversely.

8. Ice cream containing gelatin, Dariloid, Algatex, and Kragel had a satisfactory body and texture, but Kremtex seemed at times to produce a body that was slightly weak. The monoglyceride tended to make the ice cream firmer and drier and produced a crumbly body.

9. A smooth-melting ice cream was produced by all the stabilizers except Kremtex, which in some instances produced an ice cream that wheyed off slightly upon melting.

10. More than the usual amount of shrinkage occurred during storage when Kremtex and the monoglyceride mixtures were used.

Bulk Versus Packaged Ice Cream. (J. H. Frandsen and A. M. Shipley.) There is as yet no general agreement as to whether ice cream is better marketed in bulk or in packaged form. For reasons of sanitation and convenience, there is a distinct trend towards the marketing of foods in packages, and most of the arguments that apply to other foods are applicable also to ice cream. The results of this study thus far may be summed up as follows:

The amount of shrinkage incurred in the packaging of bulk ice cream is governed to a considerable extent by the serving technique and increases as the overrun of the ice cream increases. A 35 to 40 percent loss in volume results from bulk packaging as compared with packaging direct from the freezer.

Freezer-packaging produces an ice cream very definitely superior in body and texture to that packaged as bulk because it reduces temperature changes, does away with the forced pressure on the ice cream resultant from hand-packaging, and permits the packaging of ice cream in a desirable semi-soft condition. Machine-packaged ice cream can be held at a lower temperature than bulk ice cream and, therefore, keeps in better condition after it is sold to the consumer.

Factors Affecting the Sweetness Perception in Ice Cream. (J. H. Nair III and M. J. Mack.) A study was made of the percentage of butterfat, the source of butterfat, the ratio of fat to serum solids, the pH of the mix, the effects of salts present, the types of vanilla used, and the serving temperature of the ice cream and their effects on the sweetness perception in ice cream. The work has not been completed, but the preliminary study indicates the following conclusions:

There is a relation between sweetness and body and texture of ice cream.

The kind and amount of sugar in high-fat ice cream mixes definitely affect the quality of the ice cream. The use of corn syrup solids seems to prevent a crumbly texture and improves the body.

Temperature definitely affects the sweetness perception; soft ice cream tastes sweeter than hard.

DEPARTMENT OF ECONOMICS

Philip L. Gamble in Charge

Effects of the War and Readjustments in Massachusetts Agriculture. (David Rozman.) This project is devised to take account of agricultural readjustments already in progress, with the expectation of facilitating the attainment of national goals in agricultural production and of providing a basis for a program of individual and public action after the present emergency is over.

So far the investigation has been directed toward obtaining a picture of readjustments in the dairy industry as the most important factor of agricultural production in the State. By analyzing data from the Animal Inspection records it has been possible to determine the distribution of cow herds in relation to their number and size in various sections of the State. Between January 1941 and January 1942, the total number of cows two years old and over on Massachusetts farms declined from 146,424 to 141,302. During 1941 there was a general decline in the number and proportion of smaller herds; while the herds with twenty cows and over increased both in total number and in the proportion of animals in the group. The distribution of cows by size of herds will have a major effect on the agricultural labor problem because, to the extent that production is concentrated in larger herds, there will be greater need for hired labor.

DEPARTMENT OF ENGINEERING

C. I. Gunness in Charge

Cranberry Storage Investigation. (C. I. Gunness, H. J. Franklin, and H. F. Bergman.) The studies on storage of cranberries were continued during the fall of 1942. Samples of Early Blacks from the Experiment Station bog and from a commercial bog were stored in a commercial air-cooled screenhouse and in refrigerated experimental storage at two different temperatures, 45° and 35°. Both lots were picked on September 14, placed in storage immediately, and removed and screened on October 22. The storage and screening loss differed for the two lots of berries, but in both cases was greatest for the air-cooled storage and least for the refrigerated storage at 35°. There was much less difference between the two refrigerated storages than between the air-cooled and the refrigerated.

The berries from the Experiment Station bog were so well colored when picked that no appreciable change in coloring was noticeable in the different storages. Those picked from the other bog were "green" when picked. Those stored at

45° had colored best; those stored at 35°, least; and those kept in common storage were half way between.

Samples of Early Blacks from the Experiment Station bog were stored in a modified atmosphere in sealed sheet-iron cabinets in the refrigerated rooms held at 45° and 35°. This is a repetition of the trials made in 1941 and reported in the 1941 Annual Report. As explained at that time, it was difficult to remove the moisture produced by the respiration of the berries. This year more adequate means were provided for circulating the air from the cabinets through calcium chloride and no such difficulty was experienced. It was found, however, that the temperature inside the steel cabinets remained considerably higher than the temperature within the rooms in which the cabinets were placed. The cabinet in the 35° room had an average temperature of 43° and the one in the 45° room had a temperature of 50°. In comparing storage losses in the modified atmosphere with the losses in air, it was necessary to make allowance for these variations in temperature. While the results are by no means conclusive, they indicate a smaller storage loss in the modified atmosphere. It is obvious that this experiment cannot be carried out satisfactorily until a small sealed room is provided having its own refrigerating coil.

Fruit and Vegetable Drying. (C. I. Gunness in cooperation with Department of Horticultural Manufactures.) A small electric dehydrator was built during the summer of 1942 for use in the Department of Horticultural Manufactures. While planned for experimental work, the drier is of a size and design which makes it suitable for home use.

A variety of vegetables was dried during the summer and trials on the drying of cranberries are now in progress.

Poultry House Investigation. (C. I. Gunness and W. C. Sanctuary.) The housing project for 1941-42 showed an average water content of the litter varying inversely with the amount of insulation all winter from December 1 to March 11. On March 11 the water content of the litter from the non-insulated, partially insulated, and fully insulated pens was 36.6, 26.3 and 25.9 percent, respectively; the average number of birds was 77, 82, and 84; the food consumption from December 1 to February 9 was 24, 22, and 20 pounds per bird; and egg production 45, 42, and 41 eggs per bird. "Blue comb" disease and paralysis reduced production and caused considerable mortality. Each pen started in the fall with 100 Barred Rock pullets.

Horizontal and vertical temperature gradients were taken under electric hovers, some commercial and one home-made. The brooders producing the best results have a rather even temperature gradient from a low point at the outside edge of the hover to a high point in the center of the hover.

One commercial hover had a lower temperature over a rather large portion of the central area. This has been associated with a depression in the litter in the central area under the hover as if made by chicks crowding to keep warm. This particular hover has had high mortality, associated apparently with this crowding, on several occasions during severe cold snaps, sometimes early in the brooding period and sometimes during the latter part of the brooding period.

The study of soil heating cable to dry the litter in a brooder house equipped with an electric brooder was continued during the winter of 1941–42. While the litter can be dried by this means, it was necessary to rake the litter daily to get full value from the heating. Otherwise, the dry litter near the cable becomes a good heat insulator allowing very little drying at the top and permits caking at the surface. The extra work required, together with relatively high cost of current makes the practice impractical.

DEPARTMENT OF ENTOMOLOGY

Charles P. Alexander in Charge

Investigation of Materials which Promise Value in Insect Control. (A. I. Bourne and W. D. Whitcomb.) Work on a cooperative project on investigations of dinitro combinations was concerned primarily with the effectiveness of such combinations against outbreaks of European red mite during the growing season.

A surprisingly heavy infestation of red mite developed in commercial orchards in practically all sections of the State. Evidences of mite abundance and beginning of injury to foliage were noted by mid-June. The attack developed steadily throughout June and reached its peak in most sections by late July and early August. Heavy bronzing of foliage occurred in many orchards, even on varieties which usually were not considered to be particularly susceptible.

Tests with a DN dust (a 1.7 dicyclohexylamine salt of DNOCHP) and a DN spray (a dicyclohexylamine salt of DNOCHP + dispersing and wetting agent, used at the standard recommended strength of $1\frac{1}{4}$ pounds per 100 gallons) were made in nearly all the blocks of the college and station orchard, and in several commercial orchards. Uniformly good control of the mites was furnished by both DN dust and DN spray, and where the applications were made with due care and under suitable spraying conditions no injury resulted.

Special studies of different strengths of the DN spray were made in a block of Baldwin and Wealthy trees. The material was applied at the rate of 12 ounces, 16 ounces, and 24 ounces per 100 gallons. All treatments gave good control of mites on both varieties. Some slight marginal burn was noted in a few cases, but this was so slight and occurred with such irregularity that it could not be definitely attributed to the treatment and was of no commercial significance.

Toxicity tests of the DN dust and of the DN spray upon 15 different types of ornamental trees and shrubs resulted in no measurable injury to the foliage of butternut, elderberry, flowering plum, willow, rose, ornamental crabapple, privet, barberry, Norway maple, red maple, evonymus (several varieties) or magnolia. Sumac, raspberry, and grape showed slight to appreciable injury. Fortunately these would seldom require summer application of insecticides of this type.

At Waltham a commercial DNOCHP material, known as DN-111 and containing approximately 20 percent of the toxicant, was used at the rate of 24 ounces and 12 ounces per 100 gallons of water on Baldwin apple trees infested with European red mite. The spray was applied July 23 when the mites averaged 12 to 16 per leaf. Both dosages gave good control, and no serious injury to foliage was observed although the margin of some of the tender leaves was slightly scorched. As a result of these experiments and others, DN-111 appears to be a very satisfactory material for the control of summer infestations of the European red mite, and excellent control can be expected from sprays containing as little as 12 ounces in 100 gallons.

Control of Cabbage Maggot. (W. D. Whitcomb, Waltham.) The natural field infestation of cabbage maggot at Waltham was heavy and caused commercial injury to 88 to 90 percent of the untreated plants of susceptible varieties such as Golden Acre and Copenhagen Market.

The first eggs were found on May 1 which is about the average date for the last 12 years.

A study of the relative susceptibility of 13 varieties showed 4 early varieties and 3 medium or late varieties with more than half of the plants severely injured or killed and more than 80 percent commercially injured, while 2 early varieties and 4 medium or late varieties had less than half the plants severely injured or

killed and less than 80 percent commercially injured. The most severely injured varieties were Copenhagen Market and Super-curled Savoy; Early Jersey Wakefield showed the least injury.

Tests to determine the possibility of reducing the amounts of corrosive sublimate or calomel in treatments for combating the cabbage maggot during the war emergency showed that two applications of corrosive sublimate at 1 ounce in 15 gallons of water (1-1920) was equal to or more effective than two applications of this material at 1 ounce in 10 gallons of water (1-1280) which is the normally recommended concentration. Calomel-talc dust containing 2 percent calomel was very nearly as effective as the dust containing 4 percent calomel (the normal recommendation) when applied by the mound method; but was significantly inferior to the 4 percent dust when applied twice with a hand duster.

Control of Squash Vine Borer. (W. D. Whitcomb, Waltham.) As in previous experiments, spraying with 1 percent Volck plus nicotine sulfate 1-500 was the most effective treatment.

A rotenone–copper oxychloride sulfate dust containing .75 percent rotenone was also effective and distinctly more satisfactory than a pyrethrum–yellow cuprous oxide dust containing 3 percent of a petroleum solution of pyrethrins.

A DNOCHP–gypsum compound containing 20 percent of the toxicant reduced the borer infestation nearly two thirds but produced only slightly more mature squash than the check. Vines treated with a calcium arsenate–copper oxychloride dust (5.25 percent tricalcium arsenate) were more heavily infested with borers than the untreated vines but produced the largest yield in the experiment, indicating that a light borer infestation, especially after secondary roots have developed, does not seriously reduce the yield of mature squash.

Control of Striped Cucumber Beetle. (W. D. Whitcomb, Waltham.) With the existing light infestation which produced only about one tenth as many beetles as in 1941, a calcium arsenate–copper oxychloride dust (5.25 percent tricalcium arsenate) gave 90 percent protection to cucumbers and complete protection to melons, which is very encouraging in view of restricted use of rotenone during the war emergency. Rotenone–copper oxychloride sulfate dusts containing .75 percent and .5 percent rotenone respectively were about equally effective, the former giving slightly better protection on the cucumbers and the latter on the melons. It is evident that the dust containing .5 percent rotenone will be satisfactory if available. A pyrethrum–yellow cuprous oxide dust containing 3 percent of a petroleum solution of pyrethrins was less effective than the rotenone dusts but generally satisfactory. On the other hand the same pyrethrum dust without yellow cuprous oxide gave only about 50 percent protection, although the yield of melons following the treatment was the greatest in the experiments, apparently because of a partial control of aphids and other sucking insects which spread mosaic.

Control of Onion Thrips. (A. I. Bourne.) In field tests with insecticides the standard combination of nicotine sulfate and soap again proved superior to all other treatments, giving 87 percent reduction of thrips. A commercial rotenone solution proved nearly as effective and gave greater residual protection. A spray composed of castor bean extractive proved ineffective, largely because of its oily nature and poor wetting qualities. A pine oil derivative in a penetrating soap gave 74 percent control. Its effectiveness was not materially increased when derris was added. A commercial pyrethrum dust (Pyrocide) gave 70 percent control, an excellent showing for dust application and good commercial control. Fixed nicotine sprays were only moderately effective, but a nicotine tannate spray gave 74 percent effective control. A nozzle adapted to deliver a solid-cone

type of spray proved much more satisfactory and gave better penetration than the conventional hollow-cone spray.

Ladybeetles and other natural enemies of thrips did not appear in the fields in sufficient numbers to keep step with the rapid increase in thrips during late July, and there was no evidence of the presence of the fungus disease which usually appears in the fields in seasons when thrips are unusually abundant.

The Value of Control Measures to Supplement the Standard Spray Program for Apple Pests in Massachusetts. (A. I. Bourne.) The study of proposed substitutes to replace or supplement present standard materials and practices was shaped to give special attention to replacements for materials subject to curtailment because of the war emergency. This involved a determination of the value of certain non-arsenical compounds and a study of more effective timing of late season applications.

In a study of the effect of pyrethrum on overwintering larvae of the codling moth in their cocoons on the trees, a pyrethrum–kerosene solution was applied to the rough, flaky bark of the main trunk and base of the larger limbs of a small block of apples, early in April while the trees were still in dormant condition. These trees received no other application for codling moth control. Collections of both drops and samples from these trees showed less than one-fourth as many apples with codling moth stings and entrances on the treated trees, as on the checks. The pyrethrum–oil application caused no damage to bark nor retardation of seasonal development. It apparently had no permanent repellent action to codling moth larvae as indicated by approximately the same number of larvae collected in chemically treated bands, from both sprayed and untreated trees, at the end of the growing season.

This treatment eliminates the necessity for most of the scraping of loose bark from the trees and should prove very effective in penetrating the winter cocoons of larvae hibernating in piles of prop poles. These often attract large numbers of larvae and, since they are usually collected in piles at the edge of the orchard, serve as potential centers of infestation often entirely overlooked by the grower.

In orchard tests to determine the value of various non-arsenicals for codling moth control, one application of a fixed nicotine (14 percent nicotine) replacing lead arsenate in the 4th cover spray reduced codling moth damage to 1.5 percent as compared with 4 percent following the present standard schedule. Fruit from unsprayed checks in this block showed 19.4 percent injury by codling moth.

Where fixed nicotine replaced lead arsenate in the 4th cover spray and was also applied in mid-August, samples of fruit at harvest showed less than 6 apples per 1,000 damaged by codling moth.

A modified schedule in which a commercial pyrethrum–rotenone combination was applied in the 2d, 3d, 4th, and mid-August sprays practically eliminated codling moth damage. Lead arsenate was used with this combination but at reduced strength.

An application of fixed nicotine between the 2d and 3d cover sprays to furnish protection between June 12 and July 9 gave increased protection against codling moth, although the effect was not so pronounced as would be the case in a year when codling moth presented a more serious problem.

All of these materials were used with the wettable sulfur for scab control, proved entirely compatible with the fungicides, and held scab to less than 1 percent damage while samples from unsprayed trees showed 92 percent scabby fruit.

Insecticides for the Control of European Corn Borer. (A. I. Bourne.) The warm, dry weather in April stimulated corn borer activity and, as in the previous season, promoted early pupation of the overwintering larvae. Field collections

in the Connecticut Valley showed 20 to 30 percent pupation by the first week of May, and the first moths emerged on May 12. Emergence increased steadily to a peak on June 8 with a gradual reduction during the next 10 days. Coupled with the comparatively small carry-over of borers because of the light infestation in 1941, this early moth emergence, in advance of the development of the corn, resulted in a comparatively light infestation of early market sweet corn although somewhat heavier than in 1941. There was, however, a substantial build-up during the summer and a more normal infestation of the corn which matured in late August and September.

In the experimental plots the insecticidal applications, based on the first appearance of young, newly hatched larvae, were made on June 10, 15, 20, and 25. Precipitation during that period, while it totaled 2.8 inches of rainfall, was so well distributed that there was very little interference with the treatments.

Because of the war emergency and the limited supply of rotenone available, the sale of this material for use on corn was forbidden so that the field tests were confined to a study of the value of nicotine bentonite and dual-fixed nicotine.

Results from spraying with nicotine bentonite (14 percent nicotine) indicated a considerable increase in protection when 3 pounds per 100 gallons were used as compared with 2 pounds, but no advantage when more than 3 pounds were used. Protection was good in all cases. Dual-fixed nicotine dust again furnished good protection.

From the commercial standpoint the contrast between the corn harvested from treated and untreated plots was more pronounced than can be indicated by figures. Many of the ears scored as "infested" in the treated plots contained very small borers which had hatched after the last application but had scarcely penetrated the husks. A large proportion of such ears could be salvaged. Infested ears from the check plots, however, contained many large, fully developed borers; destruction of the kernels was extensive; and most of the ears were worthless.

Potato Spraying Experiments. (A. I. Bourne.) The experimental plots were planted May 4 and 5. The plants made an early start, received no serious setback to their steady growth during a long growing season, and were for the most part alive and green until killed by frost on September 28 to 29, 146 days from the date of planting.

Flea beetles appeared in large numbers as soon as the plants were up, were very abundant throughout June and early July, and again from late July until mid-August. There were no serious infestations of other insects.

The plots were given 11 applications of spray between June 5 and August 25. In view of the war emergency and the possible shortage of copper for agricultural purposes, special attention was devoted to a study of different strengths of bordeaux, and one plot was given a complete schedule of 2½-2½-50 bordeaux mixture to determine the protection furnished against disease and insect attack by the reduced dosage.

Flea beetle injury was measured by the number of leaf punctures per square inch of leaf area, and varied inversely with the strength of the bordeaux mixture. In every case the addition of calcium arsenate to the bordeaux mixture reduced the number of feeding punctures. The reduction was greatest (one half) in the plots which received the half-strength bordeaux, and was only slight in the plots which received the standard 5-5-50 bordeaux, indicating that the addition of the arsenical was an important factor whenever the strength of lime in the bordeaux was reduced.

Sufficient protection was furnished by all the different strengths of bordeaux to keep the plants alive and vigorous throughout the growing season, and scarcely a trace of blight was noted. In an adjoining plot which was sprayed with a com-

mercial neutral copper fungicide, the plants were badly riddled by flea beetle, began to die down in late July, and a large proportion were dead by late August. The yields in all the bordeaux-treated plots were very satisfactory.

The results in the plots treated with 2½-2½-50 bordeaux were very satisfactory and encourage the hope that, during the present emergency at least, reasonable protection from disease and insect pests may be secured with a considerable saving in materials.

Investigations on the Effect of Insecticides on Honeybees. (A. I. Bourne and F. R. Shaw). The investigations during 1942 were conducted along two main lines:

1. The use of materials that might be added to spray or dust mixtures to repel bees. Of those used, creosote appeared to be the most effective in repelling the bees but injured apple foliage. Tests are being continued to try to find some material that will be effective as a repellent and yet be safe on plant foliage.

2. The effect on bees of materials used as ant poisons, together with an investigation of the danger of bee poisoning resulting from the use of commercial ant baits. The ant poisons tested contained either thallium sulfate or some arsenical, most commonly sodium arsenite. Because the arsenical compounds killed the bees so quickly, there was less danger of the poison being carried back to the hive than in the case of the slower acting thallium compounds.

Experiments with commercial ant traps, used as directed by the manufacturer, indicate that very slight danger to bees will result if the ant poisons are in salve boxes or similar types of containers. The use of sweetened ant baits exposed openly would appear questionable, not only from the danger to bees but also from the aspect of safety to man and other animals.

Naphthalene and Similar Compounds as Greenhouse Fumigants. (W. D. Whitcomb and Wm. Garland, Waltham.) Experimental fumigations using a mixture of monochlor naphthalene 3 parts and flake naphthalene 1 part were continued at various relative humidities. Satisfactory control of the common red spider mite occurred only after ¾ ounce of the fumigant was vaporized in 1,000 cubic feet and the mites had been exposed for 3 hours. Fumigations at 50, 60, 70, and 80 percent relative humidity and 60°F. showed no significant differences as the relative humidity was increased, indicating that this factor is less important than temperature, which has shown increased mortality at the higher temperatures.

Biology and Control of the Apple Leaf Curling Midge. (W. D. Whitcomb, Waltham.) In emergence cages in the insectary no midge flies emerged in 1942 from maggots collected in June and July 1941, while 67 percent of the maggots collected in August transformed to flies in 1942.

Emergence of the first generation flies at Waltham was about two weeks later than in 1941 and oviposition was negligible on the trees under observation. Emergence of flies again occurred July 20–25 and August 8–15, and the greatest oviposition of the season occurred August 18–27. Larvae were collected in bands in large numbers on July 28 and on September 10, and precipitation exceeding 1 inch was recorded at each time. The influence of rain in causing the maggots to leave the rolled leaves was very noticeable.

Treatment of the soil under lightly infested trees with naphthalene flakes at the rate of 2 pounds per 100 square feet gave almost complete control of midge flies for both the first and the second generations. Spraying during the height of the oviposition period of the second generation, caused a measurable reduction in the number of infested tips where a rotenone or a DN spray was used but no reduction where a pyrethrum spray was used.

Control of Common Red Spider Mite on Greenhouse Plants. (W. D. Whitcomb, Wm. Garland, and Wm. E. Tomlinson, Jr., Waltham.) Studies of the pH of the sap of several of the host plants of the common red spider mite showed that the lower the pH of the plant sap the less time was required for the mite to develop from hatching to adult. These results are based on investigations with rose and carnation plants. Preliminary experiments with tomato, bean, sweet pea, snapdragon, gardenia, and chrysanthemum have been made and this phase of the work will be continued.

Among the experimental sprays for the control of the common red spider mite on greenhouse roses, a commercial mixture of gypsum and dicyclohexylamine di-dinitrocyclohexylphenate containing 20 percent of the toxicant, applied two or three times at weekly intervals, gave practically complete control when used at the rate of 24, 20, or 16 ounces per 100 gallons of water with Ultrawet 1-1000 as a wetting agent. On unsprayed plants in the same bench, the number of spiders increased 40 percent during the same interval.

A commercial spray known as technical mannitan laurate reduced the number of live mites 89 percent in four applications at 1-400, and 73 percent at 1-600. Two other rotenone materials gave fair control of the red spider mite and a third material was ineffective.

Several of these materials were more effective against the red spider mite on carnations than on roses.

Control of Plum Curculio in Apples. (W. D. Whitcomb, Waltham.) The effect of different amounts of spray on the control of the plum curculio in apples was studied by applying a measured quantity to apple trees of known size. An application of 1 gallon per 100 square feet was significantly more effective than an application of ¾ gallon, but 1¼ gallons per 100 square feet were not consistently more effective than 1 gallon, indicating that the results might be influenced by factors other than gallonage.

Cryolite, 4 pounds in 100 gallons, used as a substitute for the same amount of lead arsenate, gave somewhat less control of the plum curculio in apples, and caused very severe russet on Delicious apples.

Lead arsenate was used at the rate of 2, 3, and 4 pounds in 100 gallons of spray on Northern Spy for protection against the plum curculio. Results indicated that 4 pounds is necessary for satisfactory control where this insect is abundant.

Biology and Control of the Grape Plume Moth. (W. D. Whitcomb and Wm. E. Tomlinson, Jr., Waltham.) Experimental dormant applications of the commercial DN product Elgetol confirmed previous experiments which showed that a ½ percent dilution did not give satisfactory control under the same conditions where a 1 percent dilution was effective.

The effect of pruning in reducing infestation was studied on two vines. Heavy pruning (removing 79 percent of the nodes and canes) destroyed 72 percent of the eggs as compared with 55 percent destroyed by light pruning (removing 50 percent of the canes and nodes).

New Vegetable Insect Pests. (W. D. Whitcomb, Waltham.) The snout beetle, *Baris scolopacea* Germ., discovered at Arlington in 1941, was quite destructive to Swiss Chard in the vicinity of Waltham. Typical injury consisted of egg cavities and feeding punctures in the stems of the chard, making the stalks unsightly and unfit for market. Preliminary trials with applications of rotenone dust indicated that this treatment will reduce the abundance and destructiveness of this insect.

In the late summer and fall of 1942, several acres of celery, particularly in Arlington, Belmont, Waltham, and Woburn, were severely damaged or destroyed

by the plant bug, *Lygus campestris* L. Typical injury resulted from the punctures by the bugs in the heart and new stalks of the celery. The punctures were usually infected with a bacterial or fungus rot which turned the heart black, making the celery unfit for sale and often useless for any purpose. Reports from growers indicate that spraying with powdered derris and a wetting agent, prepared by the formula recommended for spraying to combat the European corn borer, is helpful and will give satisfactory control if the applications are started while the infestation is light.

The Effects of Solar Heat on the Subcortical Development of Elm Bark Beetles. (W. B. Becker.) In addition to laboratory and field work with *Hylurgopinus rufipes* in Amherst, field work with this species was also carried on in Pittsfield this summer. Work on *Scolytus multistriatus* was carried on in Springfield and Westfield.

Two brief tentative observations on the trend of the field work may be given now. (1) Freshly cut elm logs, not yet infested with the beetles, which were placed (in the early spring) in a north-south position where the sunlight could strike them all day, did not seem to become infested with any elm Scolytids on most of the upper half throughout the season. This applied to logs up to 4 feet 4 inches in diameter with bark up to 2 3/16 inches thick. (2) When Scolytid beetles were already in the bark before the logs were placed in the sun, the mortality due to the high subcortical temperatures generated by the sun's rays varied with the thickness of the bark, mortality being highest and including a broader arc of the upper surface in logs with thin bark. Some factors to be considered in this work are the weather, thickness of bark, and diameter of logs, as well as the effects of heat on different species of bark beetles.

Some New Findings of *Scolytus multistriatus* Marsham in Massachusetts. (W. B. Becker.) This species was found to be abundant at a locality in Springfield and was also found in Pittsfield. Federal scouts attached to the office of the Bureau of Entomology and Plant Quarantine at Bloomfield, New Jersey, uncovered infestations in Williamstown and North Adams.

Insect Pests of Wood and of Shade, Forest, and Ornamental Trees in Massachusetts. (W. B. Becker.) During the year, 249 inquiries were received about such insect pests, involving 72 species. Ants, termites, powder post beetles, aphids, oak twig pruners, Japanese beetles, and secondary tree-boring insects were received most frequently.

DEPARTMENT OF FLORICULTURE

Clark L. Thayer in Charge

Breeding Snapdragons for Varietal Improvement and Disease Resistance. (Harold E. White, Waltham.) Two types of resistance to rust have been observed in snapdragons. The first is inherited as a simple dominant factor which has been reported previously. The second is a modified dominant type obtained from progeny of crosses made with susceptible commercial varieties. The most promising rust-resistant strains are those developed by inter-crossing susceptible commercial greenhouse forcing varieties. These strains are 80 to 100 percent resistant to rust, free flowering in winter, and good seed producers. The plants can be propagated from cuttings and such material has been highly resistant to rust for three seasons in field and greenhouse tests.

Resistance to other diseases, such as Verticillium Wilt and Powdery Mildew, has not been conclusively determined, although in some seasons a few strains have appeared somewhat less susceptible to these diseases than commercial varieties.

Soilless Culture of Carnations. (Harold E. White, Waltham.) The use of gravel as a cultural medium has been continued for demonstration purposes and for comparison of the responses of carnations to various nutrient formulas. Four formulas were used, which gave the following number of blooms per square foot: Ball's, 14.80; New Jersey, 15.77; Ohio 2 WP Modified, 19.33; Ohio 2 WP Modified plus ½ formula weights of phosphate and potash, 18.61; soil plot (checks), 17.44.

Plants grown in soil and transplanted to gravel require considerable time for adjustment and development of a root system adapted to the gravel medium. The most critical cultural period for the plants is after they are transplanted from soil to gravel. Keeping the gravel too wet soon after planting will cause heavy losses of even the most vigorous plants; and, contrary to what has been claimed, observations show that weak plants give no better results in gravel than in soil.

A commercial grower should not find it difficult to grow carnations in gravel as far as manipulation of the nutrients is concerned; but the costs of installation at present are very high and it is impossible to obtain fertilizer salts or pumps for the duration of the war.

Cultural Requirements of Freesias. (Harold E. White, Waltham.) Freesia corms pre-cured for 2 to 11 weeks prior to planting lost from 3 to 24 percent of their original weight—a greater loss than in the two previous years because of differences in moisture content of the 1941 crop.

Corms planted August 17 to 25 required 173 days to flower; those planted October 20, 133 days; while those planted on November 1 flowered in 123 days. Freesias bloomed earlier when grown in benches than when grown in bulb pans. Increasing the growing temperature to 60°F. in mid-November hastened the blooming of early planted corms by 3 to 4 weeks.

Disease Resistance and Heredity of Carnations. (Harold E. White, Waltham.) Microscopic examinations and germination tests of pollen from 25 varieties of carnations were started in September and continued through October and November. In the early September tests pollen from the four varieties, Johnson's Crimson, Olivette, Barbara Brigham, and Peter Fisher, responded satisfactorily with 60 to 70 percent germination. Subsequent tests made at weekly intervals on pollen from these same varieties yielded very poor results. Freshly collected pollen dried in a temperature of 72°F. for 1 to 3 days and other samples exposed to sunlight for 6 hours failed to germinate. Microscopic examination of pollen did not reveal any morphological peculiarities which could be associated with poor germination responses. A few imperfect or shriveled pollen grains were common to all varieties but were not numerous enough to be considered a factor in causing poor germination.

The size of pollen grains in the different varieties did not vary greatly, ranging from 45 to 49 microns in diameter. A number of giant grains similar to those characteristic of tetraploid plants were found mixed with pollen of normal size. Typical pollen characteristics were spherical shape, external markings of extine being punctate with distinct pores.

Only 5 out of 23 varieties produced seed with self-pollination. Seed production was low, varying from 10 to 21 seeds per capsule. On the basis of observations made on germination and fertilization, it would seem that the ability of pollen to germinate is influenced by environmental conditions present at the time it is formed.

Packet Seed Studies. (Clark L. Thayer.) The Department of Floriculture cooperated with the Seed Laboratory for the seventh season in conducting tests to determine the quality of flower seeds sold in retail seed stores, chain stores, schools, and other outlets. The seeds were tested for germination and performance under field conditions. Results are reported in Control Series Bulletin 115.

DEPARTMENT OF HOME ECONOMICS NUTRITION

Julia O. Holmes in Charge

Vitamin Requirements of Older People. (A. W. Wertz.) The urinary thiamin excretion of three elderly women was followed for a period of 14 weeks. The diet was supplemented with 3 mg. of thiamin chloride for the first half of the period and then with 1 mg. thiamin plus enough yeast to bring the total thiamin to 3 mg. The excretion of thiamin in the urine was almost twice as much in the latter period as in the first period, although the intake of thiamin was identical. This might indicate that there is some factor supplied by the yeast which has a definite effect on thiamin utilization in the body. There was no change in the electrocardiograms from the first period. The hemoglobin values decreased.

The Effect of Temperature on Calcium Metabolism in Growing Rats. (Marie S. Gutowska.) One series of experiments was conducted at temperatures below 57° and above 90°F. (approximately the limits beyond which the albino rat will not breed satisfactorily); and another series at 73° and 83° (corresponding to the normal range of breeding temperatures). In both series the calcium retention was greater in the low-temperature group, whether determined by balance experiments or by carcass analysis. Growth was slower at the low temperatures. Food consumption was considerably larger in the groups of slow-growing rats kept at the lower temperatures, but food utilization was noticeably lower than in the groups kept at the higher temperatures. It was concluded that temperature plays a much greater role in practical nutrition than is now realized.

It is hoped that these findings, if confirmed by tests on adult rats now in progress, may have some bearing on the food requirements of humans as influenced by varying ranges in temperature.

The Effect of Temperature on the Cure of Rickets. (Marie S. Gutowska.) Two groups of six rats each were depleted of their vitamin D and placed in closed cabinets, one group at 66°F., the other at 82°. All received in three days 4 U.S.P. units of vitamin D. Two rats from each group were killed on the fourth, sixth, and eighth day from the beginning of the assay period. It was apparent, both from photographs and from line tests, that the rats kept at the lower temperature showed an earlier response to the treatment and an earlier healing of the rachitic sections than the rats kept at the higher temperature. It was concluded that the biological materials and the temperature at which the bioassay is conducted must be standardized in order to reduce the errors of the test; and that by lowering the temperature, it may be possible to shorten the time of the assay.

Manganese Balance Experiments with Birds. (Marie S. Gutowska with the cooperation of J. W. Kuzmeski of the Feed Control Service.) Manganese metabolism studies were conducted in two series of experiments. The first series was conducted with two groups of laying hens fed for a period of three months on rations varying only in mangenese content (76 p.p.m. and 21 p.p.m.). The droppings were collected every three hours during a period of a week and five periods of a week each formed the series. The second series consisted of the same number

of experiments but was conducted with single hens, not with groups. The rations and the droppings were analyzed and the balance of manganese calculated.

One hen on the low-manganese ration retained approximately one half of the total available manganese daily. This suggests that even 21 p.p.m. manganese in the ration was sufficient not only to keep the hen in a positive manganese balance but also to provide a surplus so that it was not necessary to store all the amount available. The hens fed for some months on the high-manganese ration did not store any manganese, and the daily output was almost exactly the total amount of the daily intake. This means that the hens were in a complete manganese balance and that the whole surplus of manganese added to this ration was voided by the hens.

Manganese and Reproduction of Birds . (Marie S. Gutowska.) Three series of experiments were conducted to observe the effects of different manganese intakes by poultry on reproduction. In the first series, there was no significant difference in the fertility and hatchability of eggs from hens fed at the low (17 p.p.m.) and the high (61 p.p.m.) manganese rations. In the second series, it was found that the hatchability and fertility of the eggs dropped significantly when the birds were fed a ration containing 14 p.p.m. of manganese; but the differences were not significant in the groups fed the rations containing 17 p.p.m. and 61 p.p.m. of manganese, and the hatchability of eggs in these groups was normal.

It was concluded that 14 p.p.m. of manganese in a laying ration is a subminimum quantity which affects reproduction unfavorably; but 17 p.p.m. is probably not far from the threshold value needed, and 61 p.p.m. is ample. Because normal commercial rations usually contain over 40 p.p.m. of manganese, they do not need, in most cases, to be supplemented with this element.

In a third series, there was a highly significant increase in the volume of sperm produced by cocks fed the high-manganese ration as compared with cocks fed the low-manganese ration. The sperm count varied considerably in the two groups of cocks and also in individual cocks on different days. However, no significant difference between the sperm count of the two groups was found. Consequently the increase in the volume of the semen in the group was due not to a change in the density of the sperm but to improved functioning of the testes.

Effect of Dietary Manganese on the Mineral Content of Some Organs of the Hens. (Marie S. Gutowska and Lewis L. Glow of the Chemistry Department cooperating.) An investigation was conducted to determine whether the manganese content of the diet would influence the mineral contents of the bones, the livers and the kidneys of the hens. One group received a high-manganese ration (61 p.p.m.); the other, a low-manganese ration (17 p.p.m.).

The ability of individual hens to store or retain minerals in their bones, liver, and kidneys varied considerably; therefore large groups of birds are needed in this kind of experiment. The ash content of the bones varied more between individuals of the same group than between the averages of the two groups.

However, the hens on the high-manganese diet had a larger amount of manganese in their bones and in their livers than did the hens of the low-manganese diet; but there was no evidence that manganese could be stored in the kidneys.

The calcium and phosphorus content of the ash of the tibias and sternums of the hens was almost the same for the two groups.

It was concluded that differences in the manganese content of the diet do not influence the calcium and phosphorus content of the bones and the liver but do influence the amount of manganese in these organs. The amounts of manganese found in the bones and livers, after twelve months on a ration lower in manganese than the average commercial ration for laying hens were considered subnormal.

DEPARTMENT OF HORTICULTURAL MANUFACTURES

F. P. Griffiths in Charge

Cranberry Research. (W. B. Esselen, Jr., R. S. Lubitz, C. R. Fellers, and H. J. Brunell.) Cranberry juice was found to have a definite bactericidal action on the oral flora and on pathogenic bacteria frequently associated with gastro-intestinal disturbances in man. This observed action appears to be due primarily to the high acidity of the cranberry.

By means of chemical and microbiological assays, the amounts of several of the vitamins of the "B-complex" present in 100 grams of fresh cranberries were found to be thiamin (vitamin B_1), 4.5 international units; riboflavin (vitamin B_6), 3 micrograms; nicotinic acid (niacin), 33 micrograms; pantothenic acid, 25 micrograms; pyridoxin, 10 micrograms; and biotin, a trace. There was little or no loss of the "B-complex" vitamins in making cranberry sauce and since the cranberries in whole cranberry sauce make up about 40 percent of the total weight of the finished product, the amount of the above vitamins present in the whole sauce was approximately 40 percent of the figures given for fresh cranberries.

Cranberries were found to contain approximately 10 micrograms of vitamin K per 100 grams, by the chick test.

Domestic Refrigeration. (J. E. W. McConnell and C. R. Fellers.) In household refrigerators left-over vegetables kept better and retained more of their vitamin C when stored in covered containers. The most rapid loss of vitamin C occurred during the first day of storage.

Storage of frozen foods for one day in the freezing compartment of the domestic refrigerator was found to be satisfactory. For storage periods of a week, a temperature of 16 F. was necessary to prevent excessive loss of vitamin C. A marked loss of this vitamin occurred at storage temperatures of 20° to 32°.

Either defrosting of frozen foods at a high temperature or slow defrosting at low temperatures resulted in a considerable loss of vitamin C.

The Nutritive Value of Mushrooms. (C. R. Fellers, E. E. Anderson, and A. S. Levine.) Work conducted during the past year shows that fresh and canned mushrooms (*Agaricus campestris*) surpass many of our staple fruits and vegetables in nutritive value. The mineral or ash content of mushrooms is high, particularly in iron. Mushrooms have been found to be one of the best plant sources of thiamin, riboflavin, pantothenic acid, and nicotinic acid. They also contain significant amounts of ascorbic acid and vitamin K.

Red Squill Research. (A. S. Levine, C. R. Fellers, and L. R. Parkinson.) Work on the toxicity of red squill (a raticide) was continued, and a standardized assay method has been developed.

Preservative Values of Organic Acids. (A. S. Levine, M. G. O'Connor, and C. R. Fellers.) The bactericidal value of benzoic acid is somewhat greater than that of several of its salts. Magnesium and ammonium benzoate compared favorably with sodium benzoate in inhibitory properties. Calcium benzoate was the least toxic of the several compounds tested. It is assumed that the undissociated benzoic acid molecule is the active germicidal agent that represses yeast growth.

Sodium chloride and ethyl alcohol in apple juices which were treated with sodium benzoate markedly inhibited the growth of yeasts. The presence of 30 percent dextrose in apple juice caused some inhibition of yeast growth, its inhibitory power being greater than that of sucrose under these conditions.

Glass Container Research. (W. B. Esselen, Jr., E. L. Moore, J. J. Powers, and C. R. Fellers.) As previously reported it has been found that ascorbic acids function effectively as antioxidants for glass-packed foods. Only that amount of ascorbic acid needed to react with oxygen present within the sealed container is beneficial as far as color and flavor changes are concerned.

The results to date indicate that the addition of ascorbic acid to fruits and vegetables naturally low in vitamin C protected them from discoloration and flavor changes. Ascorbic acid functioned successfully as an antioxidant for peaches, pears, plums, and carrots; was only moderately successful with applesauce and beets; and had no effect on such products as snap beans and peas, known to be moderate to good sources of vitamin C.

It was found that oxygen and the decomposition of ascorbic acid are the principal factors involved in the darkening of packaged orange juice. The darkening is accelerated by warm storage temperatures, but rate and intensity of darkening were significantly affected by exposure to intense light.

Deleterious flavor changes in canned and bottled orange juice occur very soon after the juice is packed, and are associated with the methods used in the preparation of the juice rather than with the type of container or the vitamin C content of the juice.

Tests conducted with glass-packed fruits and vegetables stored at room temperature for one year showed that, under average commercial conditions, there is no danger that light will cause the color to fade.

The Antioxidant Properties of D-Iso Ascorbic Acid. (F. J. Yourga, W. B. Esselen, Jr., and C. R. Fellers.) Preliminary feeding tests indicate that d-iso ascorbic acid has an antiscorbutic potency about 1/25 that of l-ascorbic acid (vitamin C).

Evidence has been obtained which indicates that d-iso ascorbic acid may be used as an antioxidant to prevent or retard the oxidation of l-ascorbic acid in packaged foods.

Fruit Jellies and Jams. (A. S. Levine, S. G. Davis, W. H. Fitzpatrick, and C. R. Fellers.) The beach plum (*Prunus maritima*) is characterized by a distinctive astringent flavor. It is relatively high in ash and carbohydrates and slightly low in pectin as compared with some other varieties of plums. A number of highly desirable products can be made from this fruit, among which jam, jelly, and butter are the most popular. Generally the fruit is deficient in pectin for jelly purposes, and addition of pectin was found necessary for the production of a high-grade jelly. No added pectin was necessary for the jam or butter.

The substitution of pectin and corn sugar for cane sugar has been found feasible in jelly making. While the jelly is of fair quality, it is somewhat higher in cost and lacking in flavor when compared with jelly made with all cane sugar.

Apple Products. (A. S. Levine, F. P. Griffiths, S. G. Davis, C. R. Fellers, J. J. Powers, and W. B. Esselen, Jr.) A cider apple jelly of highly desirable taste, flavor, and color was prepared by adding sweet Baldwin cider, concentrated to one-third its original volume, to the heat-extracted apple juice from an equivalent weight of apples. The amount of dry sugar added was about 60 percent of the apple stock used. The remainder of the sugar was naturally present in the added cider. The mixture of concentrated cider, extracted apple juice, and sugar was concentrated by boiling to a soluble solids content of 68 percent by the usual jelly manufacture procedure. Cider apple jelly is a distinctive product of attractive color and appealing flavor, superior in quality to either apple jelly or cider jelly alone.

Work has been done on the farm and home production of apple syrup to replace sugar and corn syrups. Partial neutralization of the acid in fresh apple cider with baking soda and concentration of the cider approximately seven to one produces a sweet, pleasant-tasting syrup which can be used on the table or for making apple sauce, apple butter, mince meat, or other products. As most fresh apple ciders contain between 10 and 13 percent of sugar it only requires between six and seven quarts of cider to produce one quart of syrup. Clarification of the syrup can be obtained by proper use of gelatine but for most home uses it is not considered necessary. Many New England farms having cull apples, a cider press, and a maple sugar evaporator are in a position to make large quantities of this syrup.

Marine Products Research. (C. R. Fellers and R. G. Tischer.) A successful method for canning the blue crab (*Callinectus sapidus*) which is common along the Central and Southern East Coast of this country has been developed in this laboratory. A preliminary investigation has been made to find out whether this method is equally satisfactory for the canning of the sand crab (*Platyonichus ocellatus* Latreille), an edible crustacean which abounds in coastal waters from New York to Nova Scotia. The aluminum dip method for preventing discoloration of canned crab meat was found to provide a satisfactory procedure for the packing of sand crab meat in both glass and metal containers.

The Effect of Processing on the Available Iron in Foods. (F. R. Theriault and C. R. Fellers.) The dipyridyl method for available iron gave consistent results for fruits, vegetables, and fish and checked with the bioassay method.

The commercial quick freezing of foods was found to increase the availability of iron slightly. Canning in glass had little or no effect on total and available iron.

Foods canned in tin showed changes in iron content somewhat correlated with their hydrogen ion concentrations. No change or slight gains in iron content were observed with vegetables, and considerable gains in iron occurred in the case of the more acid fruits. Fish (red perch), with a pH value of 6.9, lost half of its total iron and nearly all of its available iron when packed in tin cans lined with zinc enamel (C-enamel). With semi-acid and acid foods the iron gained from the can was nearly 100 percent available.

The Development and Control of Molds in Vanilla Beans. (F. W. Wenzel, Jr., A. S. Levine, and C. R. Fellers.) Vanilla beans which have been properly cured and aged are resistant to molds because of the presence in the beans of natural compounds, such as vanillin, which possess mycostatic properties. Improperly cured beans are susceptible to the growth of the saprophytic *Aspergilli* and *Penicillia*. Moisture and humidity regulation, refrigeration, and storage of the beans in carbon dioxide may be utilized as means of partial mold control. Ultraviolet irradiation of the beans is of little value as a control measure. Prevention of mold growth may be secured by immersion of the beans in an alcoholic vanillin solution or by vacuum fumigation with ethylene oxide.

The Use of Levulinic Acid as a Food Acidulent. (C. R. Fellers, R. G. Tischer, and B. J. Doyle.) The present shortage of the acids commonly used in foods has created a need for adequate substitutes. Levulinic acid (B-acetylpropionic acid) may now be prepared from corn at a fairly low price. Laboratory and clinical tests have shown that levulinic acid, even in excess of amounts that might be commonly used, is non-toxic to humans, rats, guinea pigs, and chickens, and suggest that levulinic acid in small amounts may be safely used to acidulate foods or beverages.

Jellies and carbonated beverages were successfully prepared using levulinic acid. Tests in bread and other bakery products indicate that levulinic acid is at best only weakly mycostatic.

Dextrose Investigations. (W. B. Esselen, Jr., H. Fram, and A. S. Levine.) It was found that sucrose and dextrose had similar effects on the thermal resistance of microorganisms commonly associated with the spoilage of acid food products.

DEPARTMENT OF HORTICULTURE

R. A. Van Meter in Charge

Nurseryculture. (C. J. Gilgut.) In the commercial culture of ornamental plants interest has been confined almost entirely to the production of esthetic effects. During the early stages in the development of a research program with plants in this class, it was necessary to devote much attention to the study of their habits to learn their response to cultural practices. While the results may not have contributed anything sufficiently conclusive to justify recommendations for use in commercial production, they have unquestionably prepared the way for the development of a sound research program which is gradually being formulated.

DEPARTMENT OF OLERICULTURE

G. B. Snyder in Charge

Variety Studies. (W. H. Lachman and G. B. Snyder.) The 1942 season was very favorable to the growing of vegetables and furnished excellent opportunity for testing some of the newer strains. Tomatoes, cucumbers, sweet corn, Pascal celery, and beans were given special consideration. While nothing significantly conclusive resulted from these tests, information has been gained concerning habits and cultural response that will serve in evaluating the merits of the several varieties and strains included in this study.

Asparagus Investigations. (Robert E. Young, Waltham.) In the asparagus breeding plots, yields from selected strains were 60 percent higher than last year. The increase in production was quite uniform for all strains, even though the best produced just twice as much asparagus per plant as the poorest. This poorest strain was commercial Mary Washington, indicating that with the proper selection of parent material the yield can be greatly increased. The order of yield of these strains has followed fairly closely the average yield of the parent plants.

Although the yield was so much higher, the average size of spear showed only slight increase, and this did not seem to be correlated with yield or size of spear in previous years.

A division of the spears, during harvest, into four different sizes showed that the percentage of both small and large spears has remained quite constant for all strains for all years and that the change has been a decrease in the medium size and an increase in the very large. The percentage of very large spears varied from 53 percent for the highest yielding strain to 25 percent for the lowest yielding; so the best strain from the standpoint of yield was the best from the standpoint of quality also.

Rust varies with seasonal conditions, but some selected strains showed only 52 percent infection as compared with 83 percent for the commercial strain. Rust of sufficient severity to cause any injury to the plant occurred on only a fourth of the total population. This compared with 14 percent on the old asparagus plants growing alongside, from which the strains under comparison were derived; and 67 percent for a row of the Paradise variety, known to be more susceptible to rust.

Vegetable Breeding for Improvement of Quality. (Robert E. Young, Waltham.) During the year breeding and general varietal studies were conducted with a number of the common vegetables including tomato, Summer Pascal celery, lettuce, rutabaga, beet, greenhouse cucumber, broccoli, and carrot. While there has been an extensive accumulation of information concerning the possibilities and habits of these several vegetables, the results are not sufficiently conclusive to justify detailed discussion, except in a few cases.

Trellis Tomato. The breeding program to improve the internal quality of the two strains of trellis tomatoes developed here was continued with a very satisfactory crop. Since most of the tomatoes that have better internal quality are later maturing, some of the desirable F_2 population has been back-crossed to Trellis No. 22 to get earlier yield. A small early tomato, Denmark, has also been used for some of the back crosses. Some new hybrids were made in the greenhouse and planted for the summer crop, to determine what varieties could be combined with Trellis No. 22 to take advantage of the hybrid vigor.

The most productive hybrid tried this year was Trellis No. 22 × Maine No. 85. This produced an early yield 44 percent greater than Trellis No. 22, with an 11 percent greater total yield, although the percentage of No. 1 fruits was only slightly larger for the hybrid. Work with this hybrid will be continued. There were other first-generation hybrids that produced an increase in yield, and the second generation hybrids were above average in early yield.

Greenhouse Tomatoes. The spring crop of tomatoes was used as a test crop in the use of a hormone spray to produce fruit without seed. Every other plant was treated by spraying the cluster about the time two to three blossoms had opened. Three applications were made one week apart, and some of the buds on the second cluster were small at the time of the last spray. The use of the hormone spray almost doubled the average set of fruit on the first cluster. The spray did not make so much difference in the set of the second cluster — 52 percent for the sprayed, compared with 39 percent for the unsprayed. For both clusters, the three sprays produced a set of 64 percent compared with 38 percent for the untreated plants. There was no noticeable difference in flavor between the seedless fruit and that having seed.

The disadvantage of this spray is that it must be confined to the flower cluster because it affects the foliage about the same as severe mosaic. The labor of putting on the spray, where it has to be applied several times, is considerable; and further trials are necessary before its practical value can be determined.

Rutabaga or Cape Turnip. As reported last year, three distinct types of Rutabaga have been developed and were ready for trial, and six lots of these three types were distributed in Bristol and Barnstable counties.

No. 1 has typical Cape turnip foliage and root shape. The chief distinguishing feature is the absence of green coloring matter in the exposed shoulder, which, however, develops a purple color when exposed to the sun. When grown with sufficient foliage to furnish shade, the shoulder as well as the bottom of the root is white.

No. 2 is a uniform type having white flesh and a green shoulder, and in general resembles the White Cape strains.

No. 3 has yellow flesh and green shoulder and is, in its general characteristics, like the White Cape. Its smooth green shoulder is quite different from that of the usual yellow type.

Careful observation and study led to the conclusion that Nos. 1 and 3 were deserving of consideration for general distribution in the turnip-growing sections of the State.

Hutchinson Carrot. A crop of seed of the hybrid carrots which have been under development was produced in the greenhouse. This hybrid strain, compared with the regular Hutchinson in the fall crop, showed better interior and exterior color with good length and shape. On account of slower growth, however, it is not so well adapted for the early market, and attempts to improve it by breeding and selection are being continued.

DEPARTMENT OF POMOLOGY

R. A. Van Meter in Charge

The Influence of Various Clonal Rootstocks on Apple Varieties. (J. K. Shaw and L. Southwick.) The stock bed set in the spring of 1940 yielded in the spring of 1942 at the rate of from about 6000 to over 20,000 rooted layers per acre. The 18 clonal types may be classified as follows:

Low yields: II, IX, X, XII, XV, A, C, Spy 227.
Medium yields: I, III, VII, VIII, F.
High yields: IV, V, XIII, XVI, Vt. 323.

This classification represents, in general, about what may be expected from these stocks, but owing to the small areas involved, there may be some that are wrongly classified. Probably Malling VIII will usually fall in the low yielding class and II in the medium class.

Many of the individual plants have died following this cutting in the second year. The number of these failures seems to differ with the different stocks. Perhaps a stock bed should be allowed to grow at least two years before severe cutting, so that larger, more vigorous root systems may be established.

The trees in our own six-year-old clonal stock orchard continue to grow vigorously and some trees have borne fair crops for their size. Thus far, there are no significant differences in the increase in trunk diameter due to stock influence. This is probably not true in all the cooperative orchards, for soil and other environmental influences are important factors in the interrelation of stock and scion.

Lethal Incompatibilities between Clonal Stocks and Varieties of Apples. (J. K. Shaw and L. Southwick.) The clonal stock Spy 227 was budded in 1941 to Stayman, Winesap, and two strains of McIntosh. In 1942 nearly all buds started to grow, but Stayman failed to develop and by midsummer most of the trees were dead or dying. Winesap failed a little later. One of the McIntosh strains grew normally all summer and the trees are now good one-year trees, while the other strain behaved like Stayman. Several strains of McIntosh and several varieties belonging to the "Winesap group" were budded on this stock in 1942 to see whether these varieties will act in the same way and how extensive this type of relation may be.

There seem to be lethal combinations between certain flowering crabs and certain Malling stocks. Bechtel crab failed to grow on Malling III. These combinations are being studied further.

Tree Characters of Fruit Varieties. (J. K. Shaw, A. P. French, O. C. Roberts, and L. Southwick.) The usual examination of commercial nurseries for trueness to name was made in the summer of 1942. While occasional new mixtures were found in inspected nurseries, the number of misnamed trees was small compared with earlier years. As the work was extended mixtures were found in cherries, pears, and plums. Increased attention is being given to peaches and thousands of misnamed peach varieties are being eliminated although it is not possible to give this as complete a service as other tree fruits. The only way to be sure that peach varieties are invariably true to name is by the maintenance of a scion orchard, known to be correctly named, as a source of renewal of budding stock.

Comparison of Cultivation and Sod in a Bearing Orchard. (J. K. Shaw.) Of the cultivated plots, one is now under the mulching system and is reported under the following project. Another which had no fertilizer from 1921 to 1927, but has since received nitrate of soda at the rate of 300 pounds per acre, has developed symptoms of both potash and magnesium deficiency. If potash is applied to correct this deficiency a magnesium deficiency will appear on soils not well supplied with this element. Where nitrate of soda alone is used over a period of years a potash deficiency appears on our soils under cultivation after about 10 to 15 years.

One of the sod plots of 10 trees which had been fertilized with nitrogen alone has received a N-P-K fertilizer and another similar plot a N-K fertilizer for the past four years. These plots now show a difference in yield, with the N-K plot yielding best. Both plots have increased yields over the period when nitrogen alone was applied thus dispelling, at least to this extent, the general contention that only nitrogen was necessary as an orchard fertilizer.

Comparison of Cultivation and Heavy Mulching of Apples. (J. K. Shaw.) The plot of nine Wealthy trees which had been mulched for 20 years continues to show superiority over the similar adjoining plot which has been under cultivation and cover crop, although no additional mulch has been applied for the past four years. There is still a thick layer of decaying mulch through which grasses, mostly quack grass, grow luxuriantly. General observations suggest that when a young orchard is planted immediately following the removal of old trees, much attention should be given to building up the soil which has been exhausted of organic matter and nutrients, because it is conceivable that old trees may be able to maintain themselves quite well on a soil so deficient that newly planted trees are unable to establish themselves and special fertilization should be provided.

The two plots in the 14-year-old McIntosh clonal stock orchard near by were mulched as last year and the yield was significantly greater than that of adjacent trees in a Ladino clover sod. No fertilizer has been applied since mulching began; while the trees in the clover have received moderate applications of nitrogen and potash. The foliage on the mulched plots was of a deeper green color and persisted longer in the fall than on the adjacent trees. No signs of a nitrogen depression have appeared on these mulched plots following the application of liberal amounts of higher carbohydrate material.

The Effect of Orchard Mulches on the Plant Nutrients in the Soil. (J. K. Shaw in cooperation with the Chemistry Department.) This project was continued by a second application of hay mulch under the mulched trees and collecting soil samples for analysis as last year. Grass growing up through the mulch of glass wool was suppressed. No differences in the behavior of the trees was observed. The objective is the study of the behavior of nutrients in the soil. Further comments may be found among the Chemistry projects.

Studies of Varieties of Fruits. (J. K. Shaw and Staff.)

Apples. Anoka has fruited for several years. It is not equal to Duchess for commercial purposes, and its only value for us is its tendency to fruit very early in its life.

Close is an early apple, first sent out as U.S.D.A. 57. It is fairly promising as a red early apple of Yellow Transparent season, but variable in size and shape.

Webster is a large red apple originated at the New York Experiment Station. It is attractive in size, shape, and color and begins to bear early but is suitable for cooking only.

Van Buren is reported to be a bud sport of Duchess. It is remarkable in that nursery trees can be distinguished from Duchess. We know of no other bud sport in propagation that can be so distinguished from the parent variety. It is promising to replace Duchess if one wants better color.

Pears. Two Bartlett-like pears, Berger and Conference, have come into bearing. Berger seems to be the more promising, but it remains to be seen whether it can compete with the well-established Bartlett. Conference seemed not equal to Bartlett.

Peaches. N. J. 105. Large, yellow-fleshed, attractive, freestone, flesh fine to firm, should be good shipper, quality good but not outstanding, will bear watching. Ripe August 20.

N. J. 102. Large, attractive, yellow-fleshed, freestone, excellent quality, fine-textured firm flesh, ripens a few days ahead of N. J. 105. Looks very promising.

Red Rose. Flavor tart and slightly astringent even when ripe, disappointing.

Blueberries. GN-87. A small crop was produced on a budded bush. The berries were very large, firm, short-stemmed, oblate, very good blue, very attractive, and very good flavor. The clusters were large and compact making picking a little hard. Skins tore some during picking. Season late medium to late. Had some mummy berry. Looks very promising.

Scammell. This variety performed much better than ever before. It yielded more and larger berries, and berry size held up better during the season. Nevertheless, the yield is still too light for it to compete with commercially recommended varieties.

Raspberries. Tahoma is a bright red berry, not firm and of poor quality. So far it does not seem promising for Massachusetts.

Washington is a large, firm berry of good quality. Worthy of further testing.

Mercy continues to promise well. It seems superior to Taylor, and may prove worthy of cultivation here.

Nature of Winter Hardiness in the Raspberry. (R. A. Van Meter and A. P. French.) A plantation of 22 raspberry varieties was set in the spring of 1942, including the hardiest varieties and those most susceptible to injury by cold. Preliminary trials of canes from older plantations suggest that the buds of varieties most often injured by low temperatures have very short rest periods.

Storage of Apples in Modified Atmospheres. (L. Southwick and O. C. Roberts, in cooperation with the Department of Engineering.) On account of mechanical difficulties with the storage room the test could not be started until November 27. The oxygen percentage steadily decreased, reaching 2 percent in three weeks, and thereafter the room atmosphere was maintained at 1 to 2.5 percent oxygen and around 8 percent carbon dioxide by periodical "washing" out of the latter and by infrequent partial ventilation to allow oxygen build-up. There is danger of anaerobic respiration, development of off-flavors, and death of apples under long-continued oxygen levels below 1 percent. The room was opened on March 17 and the apples removed.

Cortland had scalded slightly to severely even when wrapped in oiled paper, indicating that modified atmosphere storage is entirely unsuited to this variety. The Golden Delicious were in excellent condition with practically no shriveling, indicating that for this variety this type of storage may be especially suitable. The relative humidity remained high throughout the storage period and this is particularly important in successful storage of Golden Delicious. The McIntosh were variable, with condition good but quality only fair. They were already mature to slightly over-mature when the storage began to function properly late in December and, under these conditions, they came through better than expected.

On September 25, 1942, the room was again filled and at the time of writing (November 20) the storage appears to be functioning properly.

Nutrition of the High-bush Blueberry, Especially in Relation to Soil Reaction. (J. S. Bailey.) A mixture of equal parts by weight of sulfur and ferrous sulfate was found to be a good remedy for iron chlorosis. The amount required depends on the acidity and buffering action of the soil and condition of the plant.

Blueberry Culture. (J. S. Bailey.) Buds set in 1941 gave a small percentage of successes. Winter protection of the buds by sawdust was of little value because the buds failed to "take" before the sawdust was applied. Bushes were budded in 1942 at weekly intervals from July 25 to September 3 to observe the effect of time of budding. Although some buds have already died, the "take" seems to be much better than last year.

Four new varieties, Atlantic, Burlington, Weymouth, and No. 73, have recently been added to the collection, which includes all the improved varieties now in cultivation.

Preharvest Dropping of Apples. (L. Southwick.) Drop-control sprays and dusts were used on McIntosh, Duchess, and Wealthy.

With Duchess, which responded markedly to drop-control sprays in 1940, the results with dusts were disappointing although the three dusts used were partially effective. Two commercial materials applied as sprays were almost equally effective and significantly more effective than the dusts.

With Wealthy, which responded poorly to "hormone" sprays in 1940, dusts were relatively ineffective as was also one standard spray. With the other spray applications, the degree to which drop was controlled was correlated with the concentration of active chemical. These results support the conclusion reached previously that under Massachusetts conditions the stronger sprays are likely to be more effective. The added cost of more concentrated sprays may or may not prove profitable.

With McIntosh, results were variable, but in general dusts were more satisfactory than with Duchess or Wealthy. The three commercial dusts varied somewhat in apparent effectiveness but more than one season's tests are necessary to confirm that differential results are really due to "brand." Repeat

applications (four days after the initial applications) increased effectiveness and, in these cases, drop-control was substantially equal to that obtained with sprays. Applications followed in a few hours by rain were less effective. This was also true in the case of a spray which failed to dry before the onset of rain. In one instance, a second application four days after the first not only increased effectiveness but prolonged the duration of effect.

From these tests, it is evident that spray applications were, in general, more effective than dusts although the differences were not so significant but what they may be easily overcome when dust applications become more perfected. For best control of drop in Massachusetts orchards it may be necessary to increase concentrations somewhat.

Beach Plum Culture. (J. S. Bailey.) To gain a preliminary basis for procedure and to become more familiar with this fruit and its possibilities, a fertilizer experiment was started at East Sandwich in cooperation with Mr. William Foster and Dr. C. E. Cross.

A spraying experiment was also conducted consistent with the spray program outlined by Mr. Bertram Tomlinson in Special Cicrular No. 46. This program gave very poor control of plum gouger, the worst insect pest of the beach plum, but eliminated completely a gall maker which was present in great numbers on the leaves of unsprayed bushes adjacent to the sprayed plot.

Plum Pockets is one of the worst diseases of the beach plum. Plenty of infected fruits were found on older bushes surrounding the sprayed plot, but none on the sprayed plot. Brown Rot, another serious disease of the beach plum, and blights were fairly well controlled.

In cooperation with Dr. H. J. Franklin and Dr. C. E. Cross, a planting of improved selections was made at the Cranberry Station at East Wareham. These selections were supplied by Mr. J. M. Batchelor, plant explorer of the Soil Conservation Service, and are considered, by him, to be the best beach plums to be found anywhere along the east coast.

Other phases of the work are reported by the Departments of Botany and Horticultural Manufactures.

Ethylene Dichloride Emulsion. (J. S. Bailey.) Experiments to test ethylene dichloride emulsion for the control of peach tree borers were started in the fall of 1940 and continued through 1941 and 1942. Three cases of injury to trees were observed, all of which resulted from over-dosage or faulty application. No injury has been observed where applications were properly made.

Applications made September, October 1, and October 15, 1941, were very effective in controlling peach tree borers. Those made November 1 and November 15, 1941, were not so effective.

The Use of Peat in Planting Apple Trees. (L. Southwick.) In the 1940 Annual Report, a progress report was made on this experiment which began in the spring of 1939. It was reported at that time that, after two growing seasons, there was no significant difference in growth between the check and the treated trees. After two more years of growth, with scanty fertilization, the same conclusion holds.

Killing Woody Weed Plants. (J. S. Bailey and L. Southwick.) Ammonium sulfamate at three-fourth pound per gallon of water was very effective in killing chokecherries. The black cherry is much more resistant. Sprays of this material were used at several concentrations and the speed of killing of the leaves was proportional to the concentration. It is too early to determine the effectiveness of the various concentrations in destroying the whole plant.

On July 29, 1942, poison ivy in an apple orchard was thoroughly sprayed with

ammonium sulfamate at dosages of one-fourth and one-half pounds per gallon of water. By August 1 the younger leaves were considerably browned and dried out and the older leaves showed some injury. During the following week, most of the ivy appeared to be dead. The carry-over value of the treatment remains to be determined. Experience showed that care must be exercised not to get this poison ivy eradicant on apple trees.

Magnesium Deficiency in Massachusetts Apple Orchards. (L. Southwick.) In September 1939, medium to severe intervenal leaf scorch was observed on individual McIntosh trees in two experiment station orchards. These trees also showed excessive preharvest drop of fruit. A test for potassium showed a high level of this element in the leaves from affected trees. In August 1941, the same deficiency symptoms became prevalent in these and other orchards, particularly in a young orchard set in May 1939. In 1942, the trouble was evident in many commercial orchards. Other typical symptoms besides leaf scorch included occasional yellow banding and mottling and usually abnormally early leaf fall commencing near the bases of current shoot growths and progressing upwards. The symptoms suggested magnesium deficiency and chemical analyses of leaves in the late fall of 1941 tended to support this hypothesis. At that time, soil was collected from the young orchard mentioned above and Malling rootstocks were set in 2 and 3 gallon crocks and forced into growth in the greenhouse in February. Typical deficiency symptoms became evident in all pots where magnesium was not added and the trouble was most severe in the potassium-fertilized pots. Chemical analyses of the leaves showed low amounts of magnesium wherever deficiency symptoms were prevalent and high amounts where symptoms were not present.

In August 1942, leaf samples were obtained from many apple trees. Chemical analyses of unburned leaves from trees showing variable degrees of foliage scorch and leaf fall showed that there was consistent correlation between symptom severity and the magnesium and potassium leaf contents. Magnesium was always low and potassium always tended to be high in trees showing deficiency symptoms. Most of the affected orchards were on acid soils.

Just why the trouble has been more prevalent and severe in the past two years is not easy to explain although several factors may be significant. Increased use of potassium in recent years may have caused a build-up to such a point as to accentuate the need for magnesium. Increased use of mild sulfur sprays and sulfur dusts has tended to increase soil acidity. Weather conditions, particularly rainfall, may have influenced the amounts of magnesium available to trees. These are surmises only. Of course, it is probably true that magnesium deficiency in apple orchards is not new but that it had not been recognized as such.

Magnesium deficiencies may be overcome either through the use of adequate applications of high magnesium (dolomitic) limestone or, where quicker results are desired, by applying some soluble magnesium compound such as magnesium sulfate.

Temperature of Orchard Soils. (J. S. Bailey.) Thermographs were placed in the soil under two McIntosh trees in the Clark Orchard, one under a mulched tree, and the other under a tree growing in sod. The following observations were made:

1. The soil temperature under mulch was lower than that under sod from March to August; from August to late January the temperature under mulch was higher; from late January to March the soil temperature under sod and mulch was about the same and nearly constant.
2. Soil under sod warmed up faster in the spring and cooled off faster in the fall.

DEPARTMENT OF POULTRY HUSBANDRY

R. T. Parkhurst in Charge

Broodiness in Poultry. (F. A. Hays.) Results of crossing strains over a 10-year period confirm the hypothesis that two dominant complementary autosomal genes, A and C are necessary to produce the broody instinct in Rhode Island Red females. Extreme care in crossing strains is necessary to avoid bringing together these two genes.

The attempt is still being made to develop a non-broody strain of Rhode Island Reds through progeny testing. The major objective yet to be accomplished is to discover whether or not both genes A and C can be completely eliminated by this method.

A Genetic Study of Rhode Island Red Color. (F. A. Hays.) Two lines of exhibition-bred Rhode Island Reds are being developed; one selectively bred for early sexual maturity, and the other for late sexual maturity. Complete plumage color records are made on all birds, and females are trapnested for a full year to get their performance record. Feather samples are also taken at sexual maturity from all birds and these are being studied for pigment distribution.

Crosses between Rhode Island Reds and Buff Orpingtons indicate that the extension factor E for melanin pigment is not present, but that Buff Orpingtons are essentially the same as Rhode Island Reds in that the e factor permits the development of some black pigment in neck, wings, and tail. F_1 hybrids are intermediate in general plumage color, but the lipochrome pigment in skin, beak, and shanks is inhibited so that the color is white.

The Effectiveness of Selective Breeding in Reducing Mortality in Rhode Island Reds. Cooperative Project with the Regional Poultry Research Laboratory of East Lansing, Michigan, and the Department of Veterinary Science. (F. A. Hays.) Seven generations have been carried through to the age of 18 months to study the effectiveness of selective breeding in reducing mortality in one line and increasing mortality in another. The loss from cannibalism in the females of the low mortality line was double that in the high mortality line. Such losses distort the results, but there was no indication that selective breeding with small numbers is effective in reducing the mortality rate of males and females from the ordinary diseases and disorders.

Losses during this period were produced by a number of disorders but there were no acute outbreaks of disease. In many cases more than one disorder appeared in the same individual and the primary cause of death was not determined.

Genetic Laws Governing the Inheritance of High Fecundity in Domestic Fowl. (F. A. Hays and Ruby Sanborn.) At the present time particular attention is being given to the establishment of genetic uniformity in intensity of laying. Intensity is a complex character which has an important relation to egg size. Egg size has reached a satisfactory level, but intensity is still highly variable and there is considerable difficulty in combining large egg size with high intensity. The incidence and duration of winter pause have also received special attention. In other characters affecting egg production there is a satisfactory degree of uniformity in the flock.

A Study of Fertility Cycles in Males. (F. A. Hays.) In addition to the histological study of stages of spermatogenesis in males of different ages and at different seasons, still under way, attention has been given to fertility tests of males in natural matings throughout the summer. During this period the oldest male (36 months old) declined in fertility from 81 percent to 45 percent. The 24-

months-old male began with 100 percent fertility, declined to 74 percent in mid-June, but returned to 100 percent fertility in late July. The young male (12 months old) showed consistent fertility throughout the 10-week period, but his record was never equal to that of the 24-months-old male. On the female side, yearling hens were consistently higher in fertility than either old hens or pullets.

Miscellaneous Genetic Studies. (F. A. Hays.) Linkage studies between genes for shank feathering, comb form, and mottled ear lobes in Rhode Island Reds will soon be concluded. The dominant sex-linked gene has been eliminated so that stocks of crossbreds that carry only the autosomal gene E' are being developed. Progress is being made on a new method for separating the sexes in Rhode Island Red Chicks on the basis of down color. A gold-barred strain is being developed for auto-sexing chicks. The effect of ultra-violet irradiation on mutation rate is being studied. Selective breeding for abnormal sex-ratios is being carried on.

Alkaline Phosphates and Egg Shell Formation. (Marie S. Gutowska and R. T. Parkhurst, with the cooperation of E. M. Parrott and R. M. Verberg of the Chemistry Department.) Studies were conducted to throw more light on the question whether or not alkaline phosphatase is a factor in egg shell formation. It was found that:

1. The physiological mechanism of the deposition of calcium in the egg shell was independent of a local phosphatase activity factor in the shell gland (uterus) of the hen.
2. The phosphatase activity in the blood plasma of the laying hen seemed to be related to a definite genetic constitution of the hens—high productivity and good egg shell strength.
3. The deposition of calcium in the egg shell was based on a different mechanism than the calcification of the bones.
4. Phosphatase activity was very low in the shell gland, in the oviduct, and in the ova of the laying hens as well as in their bones at the time of shell formation. It was considerably higher in the blood plasma, coming within the lower range found in human blood.
5. The necessary transformation of the colloid compound containing calcium and phosphorus, and yielding calcium for the egg shell, appeared to take place in the blood itself; the shell gland acting, probably, only as an excretory organ for calcium.

Crab Meal as a Replacement for Fish Meal in the Laying and Breeding Rations. (Raymond T. Parkhurst and Emery J. Jefferson with C. R. Fellers of the Department of Horticultural Manufactures cooperating.) In further studies in which crab meal replaced fish meal on an equal-protein basis (4 pounds for 2.5 pounds) in the Massachusetts complete all-mash laying ration, corn dried distillers grains with solubles, corn distillers dried solubles, and fermentation solubles (with soybean oil meal) also replaced all the dried skimmilk in the ration.

The results confirmed previous conclusions that crab meal can replace all of the fish meal in the ration used, in which adjustment was made for the higher mineral content of the crab meal. Comparable egg production, egg weight, body weight, feed consumption, feed efficiency, egg quality, hatchability and chick quality were also obtained when the distillery and fermentation by-products replaced the dried skimmilk.

In the groups with Red-Rock crosses, the percentage hatchability of fertile eggs was higher for the rations containing skimmilk than for those containing distillers dried solubles, whether used with fish meal or crab meal and, in both cases, was higher for fish meal than for crab meal. For Rhode Island Reds, the

percentage hatchability of fertile eggs was higher for fish meal than for crab meal when used with distillers grains with solubles; but was higher for the crab meal when used with fermentation solubles and soybean oil meal.

Corn Dried Distillers' By-products in Laying Rations. (R. T. Parkhurst, C. R. Fellers, and J. W. Kuzmeski.) Complete or unsupplemented all-mash diets were fed to Rhode Island Red pullets in laying cages. All the dried skimmilk (2.5 percent) was replaced by an equal amount of dried distillers' by-products from mashes containing a high percentage of yellow corn. The by-products tested were the "screenings" or conventional light grains; the "grains," which were the grains with solubles or dark grains containing the residue (screenings) with which were dried the screened condensed stillage (solubles); and the "solubles", obtained by drying the stillage, after removal of the alcohol and "screenings."

The rations containing these by-products, each supplemented with meatscraps, gave as good production results as meatscraps and dried skimmilk, as indicated by percentage egg production, egg weights, body weight gains and egg quality. Mortality was low in all groups. Similar production results were obtained when fish meal replaced meatscraps as a supplement to "grains" and to "solubles". Hatchability was better when the "solubles" were fed. With either fish meal or meat scraps, "solubles" were comparable to milk in results obtained. With fish meal, "grains" also gave good hatchability.

Dried Cereal Grasses in Starting Rations. (R. T. Parkhurst, J. H. Vondell, and J. W. Kuzmeski.) Dried cereal grasses at levels of 1.25 and 2.5 percent adequately replaced dehydrated alfalfa meal at a 5 percent level in a meatscrap basal ration in which the vitamin D was obtained from D-activated animal sterol. In a similar comparison involving the 1942 (revised) New England College starter, equally good results were obtained with a low cost ration containing 15 percent soybean oil meal, dry vitamin D, and both dried cereal grasses and alfalfa meal, provided both fish meal and meatscraps were used. Results were not satisfactory when meatscraps were the only animal protein concentrate included in the ration.

DEPARTMENT OF VETERINARY SCIENCE

J. B. Lentz in Charge

Poultry Disease Control Service. (H. Van Roekel, K. L. Bullis, O. S. Flint, and M. K. Clarke.)

1. *Pullorum Disease Eradication.* During the 1941-42 testing season 366 chicken flocks and 31 turkey flocks were tested for pullorum disease. The results from this service are reported in a separate bulletin issued for that purpose.

2. *Diagnostic Service.* A total of 2,180 specimens in 498 consignments were examined. Personal delivery of specimens was made in 252 cases. The specimens may be classified as follows: 1,932 chickens, 190 turkeys, 11 foxes, 9 mink, 8 each of goat feces and pigeons, 4 each of pheasants and rabbits, 3 each of canine feces and geese, 2 each of dogs and quail, and 1 each of equine feces, feed, parrakeet, and sheep.

It is encouraging to note that avian tuberculosis and fowl typhoid were not encountered during the year. The former has not been widespread in recent years, but fowl typhoid began to reach serious proportions until 1939, when educational activities by the County Extension Services and the Massachusetts Division of Livestock Disease Control were apparently effective in checking further

spread. Pullorum disease is rarely encountered in chicks where owners have adopted effective measures for the eradication and prevention of this disease. Twelve new foci of fowl cholera infection were identified during the year. Fowl cholera has been found on 53 premises during the past 10 years. This disease continues to become more widespread and of greater economic importance. Listerellosis was identified in one chicken, but apparently was not a source of great trouble in the flock in which it was encountered. The 69 tumors encountered were classified on the basis of gross examination as lymphocytoma 35, embryonal nephroma 9, myelocytoma 7, fibrosarcoma 5, hemangioma 4, fibroma 2, not identified 2, hematoma 1, leiomyoma 1, and myxoma 1.

The 190 turkeys were received in 48 consignments. The diseases encountered most frequently were coccidiosis, paratyphoid, ulcerative enteritis, and enterohepatitis. Four cases of pullorum disease were poults shipped in from outside of the State. Swine erysipelas was detected in September in two flocks which were being reared in confinement. Limited observations suggest that this infection is apt to be encountered earlier in the season in birds reared in confinement than in birds reared on range; also that such an outbreak may be controlled by letting the birds out on range. This reduces direct contact between birds and stops much of the feather picking.

3. *Flock Mortality Studies.* Morbid and dead birds from the flock maintained at the College for genetic studies have been examined to determine the causes of mortality and to furnish information for experiments in genetics. This is a continuation of work similar to that conducted in former years. During the fiscal year, 340 birds were examined. Since these represent birds hatched over a period of five years, major emphasis is placed on the group which finished its first laying year during the past fiscal year. From the birds hatched in the spring of 1941, a total of 331, representing 242 females and 89 males, have been examined. No extensive outbreak of any particular disease was noted during the year, but the recognition of 13 cases of aspergillosis was unusual. Fowl paralysis was noted in an increased number of birds, despite efforts to effect a reduction through elimination of families showing a high incidence of the disease. Over three-fourths of the cases of fowl paralysis noted were in birds which had not reached sexual maturity. Fowl paralysis was noted more frequently than any other disease. Other conditions noted in order of frequency were kidney disorders, tumors, reproductive disorders, and cannibalism. Pathological conditions in birds more than 18 months of age were quite similar to those in the younger birds, except that the percentages of leiomyoma and carcinoma increased markedly.

4. *Salmonella Types Isolated.* Paratyphoid organisms isolated from diseased specimens were identified as to type. A total of 15 strains was recovered from consignments received from 10 different flocks. Twelve strains were *S. typhi-murium*, two were *S. newport*, and one was *S. derby*. The *S. typhi-murium* strains were isolated from two pigeons and ten turkeys (five poults and five mature birds). The *S. newport* and *S. derby* strains were recovered from poults. In one instance *S. typhi-murium* and *S. derby* were isolated from the same flock, but the stock originated from two different sources which may account for the presence of the two types.

We are greatly indebted to Dr. Philip Edwards, Department of Animal Pathology, University of Kentucky, Lexington, Kentucky, who identified these strains as to type.

5. *Avian Encephalomyelitis.* During the past year studies of avian encephalomyelitis were continued. Serial passage of this virus in young chicks has reached the 128th transfer. No perceptible change in the nature of the virus has been

observed. Chicks hatched from eggs laid by laboratory breeding stock revealed evidence of avian encephalomyelitis at hatching time. This observation further substantiates previous findings at this laboratory that this infection may be egg-borne.

6. *Infectious Bronchitis.* During the past year investigations in the control of infectious bronchitis were continued with the cooperation of the Extension Service and the Massachusetts Division of Livestock Disease Control. The 14 flocks inoculated with a laboratory strain of live infectious bronchitis virus in the summer of 1941 passed through the laying season without contracting the disease. In two instances evidence of respiratory infection was observed, but infectious bronchitis was not definitely diagnosed.

The results of these field investigations were received with great enthusiasm by other flock owners whose flocks had experienced this disease. During 1942 the program was extended to additional flocks in which the infection had previously been observed. Susceptible birds were inoculated or exposed to infection before reaching sexual maturity. In most instances post-inoculation reactions were favorable. However, it was noted that concomitant infections or diseases and climatic and management factors play a definite role in the response of the flock to infectious bronchitis virus. Mature birds which were regarded as immune to the infection due to previous exposure failed in every instance to contract the disease from the inoculated young stock. The results of the field trials appear encouraging, but before a practical control program is inaugurated further critical tests should be conducted.

Investigations have also been continued to develop a reliable method of detecting birds that have been exposed to infectious bronchitis infection. Such a method will serve as a guide in using this virus only in flocks that have had the disease.

7. *Farm Department Brucellosis Control and Eradication.* The laboratory cooperated in this work by testing 639 bovine blood samples by the standard tube agglutination method.

Studies of Neoplastic and Neoplastic-like Diseases. (Carl Olson, Jr.) Progress under this study was interrupted by Dr. Olson's enlistment in military service and therefore no conclusive report is possible at this time.

WALTHAM FIELD STATION
Waltham, Massachusetts
Ray M. Koon, in Charge

The members of the research staff of the Waltham Field Station are assigned to the unit by the Departments of Botany, Entomology, Floriculture, Horticulture, and Vegetable Gardening. Reports of these departments give results of investigations conducted at this station.

Soil Testing Service. Testing soil for commercial vegetable growers, mushroom growers, florists, nurserymen, greenkeepers, arborists, vendors of loam, and home gardeners has long been regarded as an important service which the Field Station has rendered. More recently this program has been extended to include service to the State Department of Public Works, the Metropolitan District Commission, Works Project Administration, U. S. Army Engineers, and town and city administrations. There is no doubt that this effort is effective, particularly when the soil test is followed by a personal interview between the client and the technician. The total number of soil samples tested in 1942 was 6134.

Field Day. Because of the shortage of gasoline and tires, and the lack of farm machinery for demonstration purposes, this annual meeting, which would have been the twenty-fourth, was not observed. Special groups and individuals, however, interested in certain particular experiments and trials visited the Station at opportune times. Among them were the New England Carnation Growers Association, Boston Market Gardeners Association, Greenkeepers Club of New England, Society of American Florists and Ornamental Horticulturists, Massachusetts Fruit Growers Association, U.S.D.A. Club, New England Seedsmen's Association, and the New York–New England Fruit Spray Specialists.

PUBLICATIONS

Bulletins -

388 Annual Report for the Fiscal Year Ending November 30, 1941. 108 pp. illus. February 1942.

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

389 Production and Prices of Milk in the Springfield–Holyoke–Chicopee Milkshed in 1935. By Alfred A. Brown and Mabelle Booth. 32 pp. illus. February 1942.

A comprehensive understanding of the productive organization and the marketing disposal facilities of the fluid milk industry is a necessary basis for sound marketing regulation. To this end, the investigation reported here was undertaken.

390 The Composition and Nutritive Value of Potatoes with Special Emphasis on Vitamin C. By William B. Esselen, Jr., Mary E. Lyons, and Carl R. Fellers. 19 pp. March 1942.

Potatoes enjoy a prominent position in the American diet. It is the purpose of this study to evaluate the nutritive properties of this popular vegetable, with special emphasis on the value of the cooked potato as a source of vitamin C.

391 A Survey and Study of Spontaneous Neoplastic Diseases in Chickens. By Carl Oslon, Jr., and K. L. Bullis. 56 pp. illus. April 1942.

Neoplastic diseases (tumors) cause much loss to the poultry industry. This collection of cases of neoplasia gives information of the characteristics and relative incidence of the different types.

392 Blooming Dates of Some Selected Hardy Perennials. By Harold S. Tiffany. 55 pp. April 1942.

A flower lover's ambition is to have some blooms available in the garden at all times during the growing season. This bulletin should be of service in the selection of perennials for that purpose.

393 Bay State, A Red Forcing Tomato Bred for Resistance to Leaf Mold. By E. F. Guba. 8 pp. illus. June 1942.

Leaf mold is a devastating disease of tomato in greenhouses and its control is difficult and expensive. This bulletin describes a new greenhouse tomato which combines resistance to certain strains of the fungus with desirable commercial fruit type.

394 The Control of Damping-off of Vegetables by Formaldehyde and Other Chemicals. By W. L. Doran, E. F. Guba, and C. J. Gilgut. 20 pp. June 1942.

Damping-off is one of the most serious problems of the vegetable grower, and the results here reported should provide safer and more effective control of the disease in hotbeds and greenhouses.

395 Preparation and Use of Artificial Manures. By Karol J. Kucinski. 12 pp. illus. July 1942.

The real or assumed dependence of crop production upon animal manures has encouraged this attempt to provide an artificial substitute.

396 Breeding Rhode Island Reds for Rapid Feathering. By F. A. Hays and Ruby Sanborn. 24 pp. illus. September 1942.

Rapid chick feathering, particularly over the back region, is a very valuable character in general purpose fowls. This study was carried on over a long period to discover a reliable method for fixing this character in Rhode Island Reds.

397 A Civilian Program for Tree Protection. By Malcolm A. McKenzie. 32 pp. illus. December 1942.

Public appreciation of shade trees in Massachusetts is evidenced by the extensive and varied planting throughout the State. This bulletin, prepared primarily to promote municipal tree management, also suggests methods of tree care in general.

Control Bulletins

112 Twenty-second Annual Report of Pullorum Disease Eradication in Massachusetts. By the Poultry Disease Control Laboratory. 11 pp. June 1942.

113 Inspection of Commercial Feedstuffs. By Philip H. Smith. 25 pp. September 1942.

114 Inspection of Commercial Fertilizers and Agricultural Lime Products. By Fertilizer Control Service Staff. 48 pp. October 1942.

115 Seed Inspection. By F. A. McLaughlin. 94 pp. December 1942.

Meteorological Bulletins

637-648, inclusive. Monthly reports giving daily weather records, together with monthly and annual summaries. By C. I. Gunness. 4 pp. each.

Reports of Investigations in Journals

385 The Effect of Storage on Carbohydrates of the Ebenezer Onion. By Emmett Bennett. Amer. Soc. Hort. Sci. Proc. 39:293-294. 1941.

399 Scoring Baked Potatoes for Texture. By Monroe E. Freeman. Food Res. 6 (6):595-598. 1941.

401 A Study of Neoplastic Disease in a Flock of Chickens. By Carl Olson, Jr. Amer. Jour. Vet. Res. 3(6):111-116. 1942.

403 Report on Soluble Chlorine in Feeding Stuffs. By John W. Kuzmeski. Assoc. Off. Agr. Chem. Jour. 25 (4):870-874. 1942.

406 Vitamin Content of Green Snap Beans. Influence of Freezing, Canning, and Dehydration on the Content of Thiamin, Riboflavin, and Ascorbic Acid. By Kenneth T. Farrell and Carl R. Fellers. Food Res. 7 (3):171-177. 1942.

412 Studies in Mineral Nutrition of Laying Hens. I. The Manganese Requirement. By Marie S. Gutowska and Raymond T. Parkhurst. Poultry Sci. 21 (3):277-287. 1942.

413 Studies in Mineral Nutrition of Laying Hens. II. Excess of Calcium in the Diet. By Marie S. Gutowska and Raymond T. Parkhurst. Poultry Sci. 21 (4):321-328. 1942.

415 A Device for Marking Fields on Microscope Slides. By Carl Olson, Jr. Jour. Lab. and Clin. Med. 27 (7):939-940. 1942.

417 The Significance of Tannic Substances and Theobromine in Chocolate Milk. By William S. Mueller. Jour. Dairy Sci. 25 (3):221-230. 1942.

418 Experimental Autoecism and Other Biological Studies of a Gall-Forming Peridermium on Northern Hard Pines. By Malcolm A. McKenzie. Phytopathology 32 (9):785-798. 1942.

419 Report on Zinc. By E. B. Holland and W. S. Ritchie. Assoc. Off. Agr. Chem. Jour. 25 (2):393-394. 1942.

421 Maintaining Fertility Levels in Massachusetts Pastures. By W. G. Colby. Soil Sci. Soc. Amer. Proc. 6 (1941):281-284. 1942.

422 The Inheritance of Blossom Type and Blossom Size in the Peach. By J. S. Bailey and A. P. French. Amer. Soc. Hort. Sci. Proc. 40:248-250. 1942.

423 Relative Inhibition of Microorganisms by Glucose and Sucrose Sirups. By L. Tarkow, C. R. Fellers and A. S. Levine. Jour. Bact. 44 (3):367-372. 1942.

424 Further Studies on the Control of Preharvest Drop of McIntosh. By Lawrence Southwick. Amer. Soc. Hort. Sci. Proc. 40:39-41. 1942.

425 Further Observations on a Narrow-Leaf Variation of the Apple. By A. P. French and Lawrence Southwick. Amer. Soc. Hort. Sci. Proc. 40:245-247. 1942.

426 Trunk Diameters of Young Apple Trees on Clonal Stocks. By J. K. Shaw. Amer. Soc. Hort. Sci. Proc. 40:269-271. 1942.

427 An Improved Orange Juice Concentrate. By A. Sedky, C. R. Fellers, and W. B. Esselen, Jr. Fruit. Prod. Jour. 21 (5):136-138. 1942.

428 An Improved Orange Marmalade of High Vitamin C Content. By A. Sedky, C. R. Fellers, and W. B. Esselen, Jr. Fruit Prod. Jour. 21 (6):170-172, 185, 189. 1942.

429 The Availability of the Iron of Cocoa and of Iron-Fortified Cocoa Mixtures. By Faye Kinder, W. S. Mueller, and Helen S. Mitchell. Jour. Dairy Sci. 25 (5):401-408. 1942.

430 The Nontoxicity of Levulinic Acid. By R. G. Tischer, C. R. Fellers and B. J. Doyle. Jour. Amer. Pharm. Assoc. Sci. Ed. 31 (7):217-220. 1942.

431 Tomato Catsup as a Source of Vitamin C. By W. B. Esselen, Jr., and H. Fram. Jour. Home Econ. 34 (9):677-678. 1942.

432 The Control of Wood Decay. By Malcolm A. McKenzie. Pests and Their Control, March 1942.

433 Cider-Apple Jelly. By S. G. Davis, C. R. Fellers, and A. S. Levine. Fruit Prod. Jour. 21 (9):260-261, 283. 1942.

434 Measurement of Texture in Baked-Potato Tissue. By Monroe E. Freeman. Food Res. 7 (6):451-458. 1942.

435 Geography of New England Soils. By A. B. Beaumont. Econ. Geog. 18 (2):203-208. 1942.

437 Propagation of Garden Sage, Salvia officinalis L., by Cuttings, Especially by Cuttings Taken in Winter. By W. L. Doran and A. M. Davis. Amer. Nurseryman 76 (5):12. 1942.

438 Effect of Freezing and of Canning in Glass and in Tin on Available Iron Content of Foods. By F. R. Theriault and C. R. Fellers. Food Res. 7 (6)-503-508. 1942.

439 Bacteriological Study of Chocolate Milk. By James E. Fuller, W. S. Mueller, and R. W. Swanson. Jour. Dairy Sci. 25 (10):883-894. 1942.

440 Cranberry Storage Tests. By C. I. Gunness. Cranberries, September 1942, pp. 7, 10.

441 The Food Value of Mushrooms (Agaricus campestris). By E. E. Anderson and C. R. Fellers. Amer. Soc. Hort. Sci. Proc. 41:301-304. 1942.

442 Effect of Apples, Tomatoes, and Dates on Urinary Acidity and Blood Alkali Reserve. By K. G. Shea and C. R. Fellers. Jour. Amer. Dietet. Assoc. 18 (7):454-457. 1942.

444 Composition and Utilization of the Beach Plum. By S. G. Davis and A. S. Levine. Fruit Prod. Jour. 21 (12):361-364. 1942.

445 Heat Capacity and Bound Water in Starch Suspensions. By Monroe E. Freeman. Arch. Biochem. 1 (1):27-39. 1942.

449 A Comparison of Four Methods for Determining Vitamin C with a 25-Day, Weight-Response Bioassay. C. F. Dunker, C. R. Fellers, and W. B. Esselen, Jr. Food Res. 7 (4):260-266. 1942.

452 Propagation of Beach Plums by Softwood Cuttings. By W. L. Doran and J. S. Bailey. Amer. Nurseryman 76 (6):7. 1942.

453 Factors Responsible for the Darkening of Packaged Orange Juice. By E. L. Moore, W. B. Esselen, Jr., and C. R. Fellers. Food Prod. Jour. 22 (4):100-102, 124. 1942.

454 The Hemicelluloses of Forage Plants. By Emmett Bennett. Jour. Biol. Chem. 146 (2):407-409. 1942.

457 Dehydrated Baked Beans. By W. B. Esselen, Jr., and S. G. Davis. The Canner, October 17, 1942.

Unnumbered Contributions

Slime Flux of Trees. By E. F. Guba. Arborists News 7 (13):17-18. March 1942

Third List of Fungi of Nantucket. By E. F. Guba and E. V. Seeler. Rhodora 44:167-175. May 1942.

Progress Report Including Transcriptions of Certain Papers Presented at the Ninth Annual Five-Day Short Course for Tree Wardens and Other Workers with Trees, M. S. C., March 30-April 4, 1942.

Indoor Culture of Plants. By L. H. Jones. p. 4.

Ferns in the Roadside Landscape. By A. Vincent Osmun. pp. 12-13.

Municipal Tree Programs in National Defense. By Malcolm A. McKenzie. pp. 29-30.

The Present Status of the Dutch Elm Disease and the Program for Massachusetts. By Malcolm A. McKenzie. Rpt. of 44th Annual Meeting of the Mass. Forest and Park Assoc., January 29, 1942.

The Dutch Elm Disease in New England. By Malcolm A. McKenzie. Proc. Annual Meeting of the Mass. Tree Wardens' and Foresters' Assoc., Boston, February 4 and 5, 1942.

Iodoform Flavor in Milk. By H. G. Lindquist. Jour. Milk Technol. 5 (6):334-335. 1942.

Butter from Goats' Milk. By H. G. Lindquist. N. E. Goat News 4 (7:)1, 9, 11. July 1942.

Control the Flavor. By H. G. Lindquist. N. E. Goat News 4 (10):1, 7, 8. October 1942.

War Time Milk Delivery. By J. H. Frandsen. Milk Plant Monthly, May, 1942. pp. 32-33.

Quality Goat Milk and How It is Produced. By J. H. Frandsen. 1941 Yearbook Amer. Goat Soc., Inc., 1942. pp. 82-86.

Orchard Insects in 1941. By W. D. Whitcomb and A. I. Bourne. Ann. Rpt. Mass. Fruit Growers' Assoc. 1942.

The Codling Moth Menace. By W. D. Whitcomb. Ann. Rpt. Mass. Fruit Growers' Assoc. 1942. pp. 27-34.

Some Observations on the Effects of Sulfur Compounds Applied During Bloom, on Bee Behavior. By F. R. Shaw and A. I. Bourne. Jour. Econ. Ent. 35 (4):607-608, 1942.

Prionus laticollis (Drury) in a Subterranean Wooden Duct for Telephone Cables. By W. B. Becker. Jour. Econ. Ent. 35 (4):608, 1942.

Benzoate as a Wartime Food Preservative. By William B. Esselen, Jr. Glass Packer, September 1942.

Should the Glass Packer Be Concerned About Light? By J. J. Powers and W. B. Esselen, Jr. Glass Packer, October 1942.

Other Preservatives for Foods. By F. P. Griffiths. Glass Packer, November 1942.

A Note on the Japanese Quince. By Arthur S. Levine. Fruit Prod. Jour. 21 (6):177. 1942.

Souring of Dates by Sugar-Tolerant Yeasts. By C. R. Fellers and J. A. Clague. Fruit Prod. Jour. 21 (11):326-327, 347. 1942.

The Non-Toxicity of Levulinic Acid. By R. G. Tischer, C. R. Fellers, and B. J. Doyle. Quart. Jour. Amer. Med. Technol., April 1942.

Does Light Have Any Effect on Glass Packed Foods? By J. J. Powers and W. B. Esselen, Jr. Ceramic Indus., August 1942.

Massachusetts Toxicity Test Assay for Red Squill Powder. By C. R. Fellers and A. S. Levine. Mimeographed. 1942.

Hopper Feeding May Require Changes in Ration. By R. T. Parkhurst. Poultry Tribune, February 1942.

Finding Substitutes for Cod Liver Oil. By R. T. Parkhurst. New England Homestead, February 7, 1942.

Government Wheat in Poultry and Turkey Rations. By R. T. Parkhurst. New England Homestead, April 18, 1942.

Northeastern Poultrymen and National Defense. By R. T. Parkhurst. Northeastern Poultryman, April 15, 1942.

Ground Barley in Poultry Feeding. By R. T. Parkhurst. Northeastern Poultryman, May 15., 1942.

Dried Distillers' Grains with Solubles. By R. T. Parkhurst. Northeastern Poultryman, June 15, 1942.

The Use of Certain Milk Replacements in Starting and Growing Rations for Poultry. By R. T. Parkhurst. Feedstuffs, May 16, 1942.

War-time Poultry Feeding Problems. By R. T. Parkhurst. Feedstuffs, October 10, 1942.

War-time Homes for Hens. By R. T. Parkhurst. Country Gentleman, July 1942.

Control of Respiratory Diseases. By H. Van Roekel. National Poultry Digest, November 15, 1942.